Patent Application of

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for

SEMI-ELLIPTICAL SAIL SYSTEM FOR WIND-PROPELLED VEHICLES

CROSS REFERENCE TO RELATED APPLICATIONS

This application is entitled to the benefit of Provisional Patent Application Ser. # 60/182207
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BACKGROUND – FIELD OF INVENTION

This invention relates to a sail system for wind-propelled vehicles, specifically a system comprising semi-elliptical sails and the means for the deployment, control, recovery and stowage of such sails.

BACKGROUND – DESCRIPTION OF PRIOR ART

Safety and speed are at opposite poles in all too many disciplines, among them sailing in its various forms. In recent years some progress has been made in reconciling the two objectives, but the major obstacle to safe, high performance sailing with low crew effort is the seeming incompatibility between the ideal, semi-elliptical sail form and safe, easy sail handling.

Historically most boats required many sails merely to approximate the ideal sail configuration, even with resort to continual and often dangerous on-deck sail changes. Ideally, in-place semi-elliptical sails would be handled exclusively from the safety of the cockpit.

Cockpit-controlled semi-elliptical mainsails exist, but counterpart in-place semi-elliptical headsails have remained a dream. Briefly stated, the problem rests in the seeming impossibility of supporting a large roach on an in-place headsail. If battens were used to support the positive roach, the sail could be neither folded nor furled. Accordingly, the modern sailing vessel remains burdened with the inefficiency and limited surface area of triangular in-place headsails.

The history of the triangular sail can be divided into two periods, pre-1925 and post-1925. In 1925 Manfred Curry identified the elliptical distribution of force over a sail as ideal for minimizing heeling forces while obtaining maximum forward drive, or optimum performance (Aerodynamics of Sails and the Art of Winning Races, Collection Biblio Voile, 1925).

While his discovery has been applied to mainsails, designers have never succeeded in applying it to in-place headsails. The disadvantages of a triangular sail are often viewed by comparing a sail to an airplane wing. These are, indeed, the two poles of aerodynamic efficiency.

The elliptical airplane wing is long and slender, or of high aspect ratio and it has little or no twist. It has minimal surface at its tip, thus minimizing the amount of air that can leak from one side of the wing to the other.

The triangular sail is opposite in all respects. It is relatively short. It twists, thus lowering not only the effective area of the sail, but also lowering the effective height of the said sail, thus maximizing the negative effect of leakage, or tip vortex.

A preliminary view of the tip vortex phenomenon places the disadvantages of the triangular sail in clear historical perspective. Frank Bethwaite, author of <u>Performance Sailing (</u>International Marine, 1993) has done extensive research and development on high performance sails, and his explanation of tip vortex is easily understood.

"If we compare the glider's wing and the yacht rig to try to understand why the yacht sail is so inefficient, four differences stand out:

...the yacht sail by comparison, is short and squat...and [air] will always leak towards the suction side. The effect is similar to the loss of effort experienced when climbing uphill in soft sand – some of the gain in height of each step is lost because the foothold itself yields downwards

The second difference is the angle to the wind at which the sail and the glider's wing work. Wings develop their best [efficiency] ratios at very small angles [to the wind]...the difference between the glider's 2 ½ degrees and the sail's 35 degrees is clearly very great.

The third difference is twist...The wings [of] any aeroplane or great sea bird in flight are beautifully designed, with no twist at all, or very little. Every part of the wing meets the air at exactly the right angle. [For yachts] twenty degrees of twist is not uncommon. Twist may be aesthetically pleasing, but it is aerodynamically catastrophic...only some tiny part of a twisted sail can be working at its best angle...the tops of twisted sails are virtually streaming downwind...[and the effect is similar to ...an untwisted sail lower in total height and of smaller area."

The loss of effective area is bad enough, but it is the reduction in effective height which is most damaging, because this greatly increases the inefficiency and loss of pointing ability due to [tip vortex]. Twist makes stubby rigs out of tall rigs.

The fourth difference is the detail of the airflow ...We can do a great deal about twist and airflow...Two modern developments control twist

positively to the point of eliminating it...The first is the fully battened sail with a roach."

The second is controlling the elasticity of the upper leech area of a sail, which subject will be reviewed below as it pertains to the present invention. Eventually this enlightenment in sail design was applied, but only to a limited degree, in mainsail design. Although ideal headsail form has been known since 1925, applying this ideal to in-place headsails has remained a dream

The reality is that the following specific headsail design objectives have remained unsatisfied:

1. Elliptical in-place headsails adaptable to any sailing vessel;
2. Controlled deployment and recovery of vertically deployed working jibs;
3. Self-contained in-navigation jib control means
4. Convenient, in-place stowage for vertically deployed jibs;
5. Truly versatile furling headsails:
6. A minimum wardrobe of semi-elliptical sails, which wardrobe achieves the foregoing objectives and is thus capable of adapting any sailing craft to changing conditions;
7. Lower costs and higher profits in sail and sailboat construction plus greater market penetration;
8. Synergy in sail system design

1. ELLIPTICAL IN-PLACE HEADSAILS ADAPTABLE TO ANY SAILING VESSEL

The horizontally battened configuration, which is appropriate to a mainsail is not appropriate to headsails, which are either rolled around their stays when not in use, or folded, depending on whether such sails are horizontally or vertically deployed. Thus, the highly efficient elliptical form has been considered inapplicable to in-place headsails.

The only application of the semi-elliptical form to headsails was to free-flying sails such as spinnakers and gennakers. Such sails must be hoisted, lowered, and stowed with each change in wind and sea conditions, with inevitable safety and crew effort disadvantages.

As efficient as is the elliptical form, so is the triangular sail form inefficient. A triangular sail creates tip vortex far in excess of a semi-elliptical sail, and the sail becomes a brake rather than a driving force as the vessel sails closer to the wind. Equally important is the dramatic reduction in heeling force achieved by a semi-elliptical sail.

The negative effect of heeling forces caused by triangular sails cannot be overemphasized, along with the limited ability of triangular sails to maintain forward drive at close angles to the wind in irregular sea conditions. Finally, triangular sails have a low tolerance to changing wind angles relative to a semi-elliptical sail and must be adjusted more frequently than the latter. These factors are largely responsible for the limited use of sail power in modern cargo and passenger transport.

The ability of a sail to respond dynamically and immediately to changing wind conditions depends particularly on the design of the upper part of a sail. Twist in the upper part of semi-elliptical sail is controlled far more easily than with a triangular sail, thus guaranteeing that the full height of the semi-elliptical sail performs efficiently, and that tip vortex is minimized. Equally important, a semi-elliptical sail responds more quickly, in its upper part, to wind changes, thus requiring far less sheet handling than a triangular sail and producing greater boat stability.

If the upper part of a sail twists off, a tall rig instantly becomes a stubby rig (High Performance Sailing, Bethwaite, International Marine 1993). Bethwaite identifies the problem and the extent of solutions to date: "I always find it fascinating to re-read Dr. Manfred Curry's book, ...published in 1925...Manfred Curry, for all his genius, could not alter his sails' shapes."

The fully battened mainsail and, more recently, windsurfer sails, have employed a semi-elliptical form to achieve the potential Curry saw but could not achieve over 65 years ago.

Until now, it was considered impossible to reconcile in-place headsail deployment, recovery and stowage requirements with a large positive roach, or semi-elliptical form, and semi-elliptical, in-place headsails remained on designers' wish lists.

2. CONTROLLED DEPLOYMENT AND RECOVERY OF VERTICALLY DEPLOYED WORKING JIBS

Initially, headsails were hoisted and lowered, or vertically deployed and recovered, during which maneuvers the body of the sail was unstable. This instability could result in sail damage and require potentially dangerous crew maneuvers.

Control means for vertically deployed mainsails, "Lazy Jacks", appeared and have been widely used, but the control lines tend to foul batten ends during mainsail deployment. Subsequently, the patented Dutchman System, U.S. Patent 4,88,506 to Van Breems (1987) addressed this problem.

Both lazy jacks and the Dutchman System are now widely used for controlling vertically deployed mainsails during deployment and recovery, but not for controlling vertically deployed working jibs, which have also remained on designers' wish lists.

3. SELF-CONTAINED IN-NAVIGATION JIB CONTROL MEANS

Headsails may be divided into two basic classes, non-overlapping, and overlapping. In both cases, headsail control during navigation addresses first, the angle of the sail to the wind, or sail trim, along with maintaining leech and foot tension to present an efficient, dynamic form despite

changing wind and sea conditions. A third and equally important element of headsail control concerns the reduction of surface area, or reefing. A fourth element concerns the stability of the body of the sail in changing conditions and during tacking and jibing.

Non-overlapping sails, or working jibs, may be self-tacking, as opposed to overlapping sails, or genoas, which require releasing one sheet and placing the other in tension with each change of tack. A major impediment to constantly efficient sail shape is presented when a headstay sags as the wind increases. The headsail becomes fuller, which is the opposite of what is desired, resulting in increased heel.

Working jibs may be vertically deployed or horizontally deployed, and the respective advantages of each are covered immediately below. Overlapping headsails, whether vertically or horizontally deployed, will be considered in a separate section, following comments on control of working jibs during navigation, found immediately below.

4. CONTROL OF VERTICALLY-DEPLOYED WORKING JIBS DURING NAVIGATION

In theory, self-tacking jibs deliver major safety and convenience advantages. However, such advantages go largely unused due to the limited versatility and efficiency of small triangular working jibs. Such sails are too small and inefficient to be of use except in heavier winds, thus limiting their functional versatility and market potential.

In addition, known control means for such sails did not provide the safety and convenience now demanded by the great majority of sailors. Simply stated, small triangular working jibs are inefficient and are incapable of use in extended wind ranges.

Booms as well as wishbones appeared for controlling working jibs, and patents have been issued for developments of each, US Patent 4,503,796 to Bierig (1985) and US Patent 5,463,969 to Hoyt (1995).

While such jib booms and wishbones do provide means for controlling sail trim and to a degree, control of leech and foot tension, such jib booms and wishbones remain costly, heavy spars, usually requiring extensive deck modifications and taking space below deck.

Such booms and wishbones provide none of the following:

a. Integral means of controlling its sail during deployment and recovery:

b. integral means for stabilizing the subject sail during navigation;

c. convenient means for reefing the subject sail from the cockpit.

d. sail. Automatic stowage means for containment and protection of the subject

e. Dynamic response to changes in wind and sea conditions, being rigid spars.

At considerable expense, and with significant deck modifications, such jib booms and wishbones do allow a working jib to be self-tacking, thus allowing the sailor to turn the boat through the wind without alternating jib sheets. This is a major advantage, yet only a limited number of sailors opt for self-tacking jibs. The Bierig half-wishbone does combat the effect of a sagging headstay, but its rigidity constitutes a breakage risk and is not dynamically responsive to wind and sea changes. The Hoyt boom does not combat the effects of a sagging headstay at all.

The limited popularity of self-tacking jibs is due not only to the abovementioned disadvantages of booms and wishbones for such sails, but is due as well to the limited versatility and efficiency of such small triangular jibs, themselves. A self-tacking sail with integral lightweight control means also remained a dream.

Two international yachting magazine editors cite specifically both the unavailability of, and the market potential for an easily handled and truly versatile self-tacking working jib. Recently, each built a one-off cruising sailboat, and each identified a self-tacking headsail as an indispensable design element. Each of them resorted to a costly and cumbersome jib

boom requiring extensive structural deck modifications, and each opted for a furling jib despite increased cost and weight aloft.

Neither of these highly knowledgeable and experienced sailors found a boom-free means to a self-tacking jib, and both chose a furling sail despite their greater cost and weight aloft. Once again, the seemingly impossible imposed unwanted compromises upon even the most highly knowledgeable sailors and their respective naval architects.

Constance Wales, editor of the U.S. magazine, Sail Magazine, explained why the vertically deployed triangular working jib on her former boat, Boston Light went largely unused, and why she resorted to a furling working jib for her new boat:

"Boston Light had neither roller-reefing nor a traveler for the staysail. **As a result, we didn't use the staysail much, except on long passages…as a heavy weather headsail**. On the new boat the staysail will be roller reefing, and we wanted to find a way to have it **self-tacking as well so we would use it more**. The design of this sail and its controls took lots of thinking about."

"Most of the time we'll be sailing with one person on watch, and thus are willing to give up a bit of performance in the interest of easy sailhandling… A staysail rigged for self-tending through tacks and gybes won't require attention. … **…This is a tradeoff**." (Sail Magazine, Feb. 1998).

Andrew Bray, editor of the British magazine, Yachting World, likewise built a custom cruising boat during this period, and designed his boat around a single roller furling stay and a boomed, self-tacking furling working jib. He used a patented Hoyt jib boom and a non-overlapping roller furling working jib.

Mr. Bray noted the high cost of the boom and loss of most of the space in his anchor well to the boom support receptacle. The Bray boat has a

single headstay, making it necessary to go forward to set a free-flying headsail for light air conditions. The Wales boat has twin headstays, and carries a triangular light-air furling sail on the forward furling stay.

Summarizing the experience of these two yachting magazine editors illustrates clearly that:

a. self-tacking working jibs are central to ease of use and safety regardless of the skill level of the boat owner;

b. heretofore, self-tacking working jibs have suffered from inadequate surface area and inefficient form, and were not useful in light and medium winds;

c. in-place, semi- elliptical multi-condition headsails were not available, even to such highly knowledgeable boat owners;

d. deployment, recovery, and stowage issues were resolved by resort to furling jibs, as opposed to vertically deployed jibs, despite the lower cost and weight aloft of the latter;

e. the booms used in both the above cases for sail control, imposed costly structural modifications in addition to the cost of the boom installation, itself;

f. Two headstays were used on Constance Wales' boat,. A light, but inefficient in-place triangular furling genoa is carried on the forward stay to avoid on-deck sail handling.

On the single-stay Bray light air headsails must be brought on deck and hoisted, then lowered and stowed each time conditions demand, imposing considerable effort and risk in order to adapt the boat to changing conditions (Yachting World, March 2000).

In commenting recently on a newly introduced single-stay fifty-foot sailboat, the editor of the US magazine, Sailing, Bill Schanen, said,

"The boat has a permanent roller-furling staysail [as in the case of the Andrew Bray boat]. To set the forward headsail, which would be used in light and moderate weather, someone has to go to the bow to ...[set] it,

as in the old days...Only for the truly pure at heart, I'm afraid (Sailing, Jan. 2000)."

Clearly, strong market demand exists for more powerful and efficient vertically deployed working jibs as well as more powerful and versatile in-place semi-elliptical furling headsails, particularly if such sails could be furled to truly effective working jib size. Known jib rigs have never reconciled minimum performance requirements with safety, versatility and ease of use.

The specific comments of these three highly experienced and knowledgeable sailing magazine editors make clear that convenience and safety are increasingly in demand, and that performance compromises are begrudgingly accepted in order to achieve highly desired convenience and safety features. .

Market demand has long existed for a more powerful and efficient working jib and powerful and truly convertible genoa-jibs. Until now design solutions to meet such demand have been considered unattainable.

REEFING

Reefing a vertically deployed jib by tying in reefs was difficult and dangerous, and the result was entirely unsatisfactory. Thus, either such vertically deployed jibs were removed and replaced by another vertically deployed headsail, or multiple headstays were used to adapt a boat to changing conditions.

Both alternatives imposed high cost, stowage problems, and dangerous sail maneuvers. The advantages of the vertically deployed jib appeared irreconcilable with the safety and ease of use demanded by the market. The sailor was left to highly compromised alternatives for reconciling performance with safety and convenience requirements.

Ease of reefing and the efficiency of the reefed jib are primary sail control

considerations. While roller-furling headsails impose performance compromises, particularly when partially furled, they have eclipsed vertically deployed headsails commercially because furling sails can be deployed, reefed, and recovered from the cockpit, albeit with compromised efficiency when partially furled, or reefed.

The safety and convenience that furling sail systems offer override their performance shortcomings for the great majority of users, notwithstanding their higher cost, compromised performance, and increased weight aloft. Again, the sailor is left with an unattractive set of alternatives.

5. CONVENIENT IN-PLACE STOWAGE FOR VERTICALLY DEPLOYED JIBS

Protective stowage of vertically deployed working jibs has heretofore been a cumbersome process, typically accomplished by removing the headsail from its stay and placing it in a large bag for stowage below or on deck, generally resulting in abuse of the sail and potentially dangerous crew maneuvers. Boomed jibs often carry covers similar to conventional mainsail covers, which must be removed, stowed, and replaced, leading inevitably to an unprotected sail and reduced sail life. Non-boomed jibs were even less likely to be protected regularly.

Efforts to improve non-boomed headsail stowage, such as that found in US Patent 4,026,230 to Wilford (1977) involved bags that contain a lowered headsail attached to its headstay. Such bags offer nothing in the way of automatic sail control, automatic sail flaking, or reduced crew risk and effort during deployment and recovery. They simply contain a lowered sail after it has been forced into a small enough volume to fit the bag. This process is difficult and requires sometimes dangerous on-deck sail handling.

As in the case of sails themselves, reasonably satisfactory automatic stowage means did appear for mainsails, but never for headsails. Such mainsail stowage bags are often called "lazy bags". The cost of most such bags is roughly equivalent, and they must be made to exact measurements in the sail loft. Any error in measurement requires returning the stowage cover to the sail loft for modification. On-board sizing of such lazy bags has never been achieved, and any potential modification costs of such bags must be factored into their sales price.

Such bags provide reasonably satisfactory in-place mainsail stowage means. Such bags are inappropriate for jib stowage and are not so used because they present a high profile, open-ended configuration to the wind and must be supported by lazy jacks or by the sail itself. These very factors are not only incompatible with jib stowage, but they compromise the value of known lazy bags, even for mainsail stowage.

The particulars of one such cover are found in US patent 4,741,281 to Doyle (1988). The Doyle bag is a high profile, open-ended bag, which is sewn to the sail in the sail loft, yet still requires lazy jacks. Its production cost exceeds that of other lazy bags, which bags are typically supported by lazy jacks without being sewn to the sail.

In addition, such open-ended covers are inappropriate to in-place stowage of vertically deployed working jibs because the lazy jacks that invariably support such bags can foul battens and present considerable clutter and windage, thus reducing jib efficiency. An aerodynamic automatic jib stowage bag supported independent of lazy jacks fills yet another place on the designers' wish list.

6. CONTROL OF OVERLAPPING FURLING SAILS DURING NAVIGATION

Roller furling headsail systems introduced a relatively satisfactory means

for the control of triangular headsails, and, to a lesser extent, reefing them. However, the body of a conventional triangular furling headsail is unstable in changing wind conditions, and a heavily reduced triangular furling sail presents an inefficient sail form for increasing wind conditions, being too small for effective propulsion, and having a clew too high for effective sheet angles. Such sails are noisy in unstable wind conditions and are prone to accelerated wear due to uncontrolled flogging of the body of the sail.

Sail trim for overlapping roller-furling sails is achieved by means of sheets led to port and starboard genoa cars. Such control means allow sheet angles appropriate to varying wind direction until a sail is furled too far in to allow a correct sheet angle.

On such furling sails, foot and leech tension are typically controlled by foot and leech lines. Such triangular furling sails are unstable in varying wind conditions, regardless of how such sheet angles and foot and leech tension are regulated. Additional means are required to stabilize overlapping furling headsails.

Numerous attempts have been made to stabilize furling sails with flexible horizontal battens and even inflatable horizontal battens. On rare occasions, vertical battens have been applied to triangular furling headsails merely to improve sail shape when the said sails are partially furled, but not to stabilize the body of the sail, and never to support a positive roach. These efforts proved unsuccessful commercially due to functional problems, or due to cost not justified by benefits in performance and convenience.

The market demand for integrated means for optimizing the stability of both overlapping and non-overlapping in-place furling headsails and for supporting a positive roach in such sails has remained unsatisfied. Such headsails have been restricted to the inefficient triangular form, and true versatility for furling headsails has remained an item on the designers' wish list.

7. CREATION OF TRULY CONVERTIBLE, EASILY CONTROLLED FURLING HEADSAILS

The impossibility of constructing a roller-furling headsail convertible from an overlapping headsail, or genoa, to a truly effective self-tacking working jib was reiterated recently by Walt Schultz, well known US boat builder and naval architect, who owns Shannon Yachts:

"… today, it is still impossible to roller furl a large overlapping genoa into a useable and safe working jib." (Ocean Navigator no. 100, 1999)"

Such a sail would eliminate significant inconvenience, risk, and the cost of multiple headsails.

Similarly, it has been considered impossible to construct a maximum-surface in-place furling sail for replacing free-flying spinnakers and gennakers. This is borne out by the experience of both Andrew Bray and Constance Wales in designing their dream boats. Such a sail would offer light and medium-wind performance sailing without the need to hoist, lower, and stow a conventional free-flying sail every time wind or sea conditions change.

Once again, the market's demand for safety and convenience proved irreconcilable with minimum performance requirements.

While free-flying spinnakers and gennakers employ a semi-elliptical form, they impose added cost, added equipment, and on-deck sail handling, as opposed to an in-place furling sail, which remains in place in all wind conditions, and which is controlled entirely from the cockpit.

The effort and risk of on-deck sail handling may be acceptable to racing sailors, but it is unacceptable in the cruising context, as confirmed recently by the abovementioned comments of Bill Schanen, editor of Sailing magazine.

Free-flying sails, even those on flexible furling luff ropes, require crew to go forward to deploy and recover them each time conditions change. Such sails cannot be left in place, then furled and unfurled as wind and sea conditions demand. Fatigue and increased risk to crew and material inevitably accompany such sails.

Therefore, true versatility has remained unattained for both vertically deployed headsails as well as in-place horizontally deployed furling sails. In neither application does the triangular sail form deliver the efficiency or surface area requisite to a truly versatile headsail, be it a working jib or an overlapping headsail.

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8. LOWER COSTS AND HIGHER PROFITS IN SAIL AND SAILBOAT CONSTRUCTION

The conventional triangular sail has long imposed limitations in efficiency and surface area upon sail makers and boat builders alike. In order to gain performance, taller masts were utilized, thus requiring increased ballast, larger rigging, and higher construction costs. Recently, exotic materials such as carbon fiber for masts and booms reduced weight aloft and improved performance in some cases, but at sharply increased boat cost. Thus, the triangular sail continues to impede economies in sail making and sailboat construction.

8.SYNERGY IN SAIL SYSTEM DESIGN

Sail designers seek to utilize the venturi theory and to reduce its limitations, as seen in the relationship between jibs or genoas on the one hand, and mainsails. One such design used multiple furling jibs and no mainsail, thus providing ease of use and, in theory, improved windward performance. .US patent 4,345,534 (1979) to Carter.

The Carter design utilized triangular furling sails with a particular sail camber and sheeting angle for closehauled navigation. Mr. Carter produced several examples of this rig, known as a "Luna" rig, but the

design did not enjoy ongoing commercial success. It was criticized as sacrificing too much in performance due to the limited sail area and efficiency of its triangular sails. In addition, it was considered ill adapted to downwind sailing since none of the small triangular sails were boomed or vanged. The Luna rig's sails were equivalent to furling working jibs, whose disadvantages were discussed, above.

A sail system utilizing multiple cockpit-controlled semi-elliptical sails having integral stowage and control means, and that work together synergistically to improve performance, safety and convenience takes yet another place on the designers' wish list.

UNRESOLVED HEADSAIL DESIGN OBJECTI VES

Accordingly, unresolved headsail design objectives include the following:

1. Semi-elliptical in-place headsails, whether horizontally or vertically deployed;

2. A vertically deployed self-tacking elliptical jib with integrated control and stowage means;

3. A versatile, in-place roller furling headsail capable of replacing maxi-genoas and spinnakers.

4. Improved cost to performance relationships in sail and sailboat design and construction

5. Improved ratio of drive to heeling forces.

8. Adapting furling sail to the needs of commercial cargo and passenger transport.

9. A minimum synergistic sail wardrobe which achieves the above design

objectives, and which is appropriate to virtually any sailing craft.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, a synergistic sail system adaptable to any sailing craft, comprising:

a. Sails employing a semi-elliptical form;
b. integral means for controlled deployment and recovery of such sails;
d. integral means for controlling and stabilizing such sails during navigation;
e. true headsail versatility;
f. Maximum safety and ease of use;
g. Improved cost to performance relationship
h. Improved profits and margins for sail makers and boat builders

The present invention satisfies and reconciles these heretofore incompatible elements, thus comprising a plurality of individual elements unique in themselves.

Each individual and unique component of the present invention produces unexpected results, and in combination, such components provide a marked synergy of result.

OBJECTS AND ADVANTAGES

The several advantages of the present invention are considered, first, as they favor vertically deployed headsails, then as they favor horizontally deployed headsails. In each case, a distinction is made between in-place non-overlapping sails or jibs, and in-place overlapping sails, or genoas.

ADVANTAGES FOR VERTICALLY DEPLOYED WORKING JIBS

a. Controlled sail deployment and recovery;

b. Integral booming and vanging afford continual, dynamic sail control by means of lightweight, inexpensive semi-rigid battens or batten substitute means:

c. Maximum sail area coupled with maximum efficiency by means of elliptical sail form;

d, In-place low profile automatic jib stowage means;

e. Reduced heeling resulting in increased speed and comfort;

f. Self-tacking ease of use coupled with higher performance;

g. Reduced cost and weight aloft as compared to furling jibs;

h. Dynamic response to changing wind and sea conditions requiring less frequent sail adjustment and constant driving force from a sail's entire height

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The present invention presents the unique combination of integral booming, vanging, and control means, plus in-place, automatic stowage means for a semi-elliptical vertically deployed working jib. In contrast to the external devices examined above, including the rigid Hoyt jib boom and rigid Beirig half-wishbone, the present invention insures dynamic working jib response to changing wind and sea conditions, whereby the subject working jib is instantly responsive to such changing conditions and requires a minimum of sheet adjustment.

The semi-rigid battens of the subject jib 23 allow the said sail to take optimum shape very quickly as conditions change, while preventing the sail from collapsing in variable wind and sea conditions. The subject jib also becomes flatter as its stay sags, which promotes forward drive and minimizes heeling forces. Rigid control devices including the Hoyt Boom and Beirig half-wishbone cannot provide this combination of benefits.

The said working jib can be produced at small incremental cost over conventional jibs, and at far less cost than that of a jib plus boom or wishbone. The subject sail provides fully integrated and self-contained control features in sharp contrast to the less effective control means

provided by expensive and cumbersome external booms and wishbones.

Requiring no additional equipment or deck modifications, the subject self-tacking jib provides optimum performance in a semi-elliptical working jib, which is deployed, trimmed, reefed, and recovered from the cockpit. Its performance far surpasses triangular working jibs.

The said sail is quiet and stable during sail handling procedures, which are performed entirely from the cockpit, not from the deck. The said semi-elliptical working jib is quickly stowed in its companion in-place automatic jib stowage bag. Unlike conventional jibs that impose flogging sails,on-deck sail handling, and considerable time and effort attributable to eventual bag removal and replacement, the uniqueness and synergy of the said jib and automatic stowage bag makes sailing fast easier and safer.

Major gains in safety and convenience, coupled with important increases in performance, contrast sharply with the performance and safety compromises of conventional working jibs and stowage means. The small incremental cost of the said jib and companion automatic stowage bag make for dramatic increases in the relationship between cost, performance, safety, and convenience. The combination of the jib and bag produces a considerable synergy in terms of the convenience of in-place automatic stowage that has little, if any negative effect on jib performance.

While the foregoing discussion covers only working jibs, evolving technology will likely make possible batten substitute means consistent with a batten-free, semi-elliptical, vertically deployed overlapping sail that can be easily folded and stowed. Such a sail is an alternative embodiment of the present invention and is described below

MARKETING ADVANTAGES OF THE PRESENT INVENTION AS APPLIED TO WORKING JIBS

The **marketing advantages** of the said vertically deployed semi-elliptical working jib are considerable. First, by virtue of its increased semi-elliptical surface area and efficiency, the said sail has sufficient power to meet minimum performance requirements without recourse to constant on-deck sail changing.

On the water testing performed by the present inventor over an extended period indicate that the mean driving force of the subject jib is equivalent to that of a 125% triangular genoa. In addition, the said jib can provide drive at angles quite close to the wind while sailing or motor sailing. In the latter case, boat stability is far greater than in the case of a triangular working jib, and fuel economies as well as improved boat motion are achieved.

Cockpit sail handling, including reefing is finally reconciled with optimum performance, and with safety requirements in the use of vertically deployed jibs. Reduced passage times and increased comfort translate to reduced crew fatigue and risk of injury.

When used on twin headstay boats, the semi-elliptical sails of the present invention produce a performance synergy due to their elliptical form. The said form considerably reduces heeling effect, thus simultaneously increasing performance and comfort aboard, and it is believed that the performance relationship between two semi-elliptical sails is superior to that between two triangular sails.

The above features make the said sail particularly attractive for boats with small crews. The already low incremental cost of the subject sail is far outweighed by major safety, performance and convenience benefits. The subject jib is particularly well-suited for use downwind, whether in combination with a mainsail or with another headsail by virtue of its efficient shape and its self-booming and self-vanging features. Pole-free

sail stability, which was formerly considered impossible is now a reality.

In addition, increased sail life resulting from reduced sail vibration and the ease of regularly and automatically stowing the said sail in its automatic in-place stowage bag results in major savings .

The **automatic jib stowage means** provided by the present invention provides important and unique advantages over existing stowage means while delivering production economies.

1. Closed ends and low profile eliminate instability and are appropriate to jib stowage in contrast to conventional high-profile, open-ended bags which are not aerodynamic, and which are prone to control problems.
2. The said automatic jib stowage bag does not depend on lazy jacks or the sail, itself, for support. This advantage contrasts with typical lazy bags, including the Doyle bag.
3. The present invention provides a bag that can be sized on-board, thus making it appropriate for wide-market sales, as opposed to known designs, which require in-loft fitting and, in some cases, in-loft attachment to the sail, and which therefore bear distinct marketing disadvantages.
4. The said automatic jib stowage bag remains in place during navigation, thus eliminating the removal-replacement effort demanded by conventional jib stowage bags, even those used in conjunction with jib booms or wishbones.
5. In-place automatic stowage means encourage systematic sail protection, thus extending sail life considerably. The nonexistent or small incremental cost of the said automatic jib stowage bag is more than compensated by reduced effort and prolonged sail life.
6. The said automatic jib stowage bag is equally appropriate to mainsail stowage, and like advantages apply to such application, as developed below. This embodiment is addressed in the drawings and their description as contained in the present application under "Alternative Embodiments".

ADVANTAGES OF THE PRESENT INVENTION FOR HORIZONTALLY DEPLOYED HEADSAILS

As concerns horizontally-deployed, or furling headsails, the present invention takes two basic and unique forms, a semi-elliptical genoa convertible to a truly effective self-tacking working jib, and an in-place semi-elliptical furling for replacing gennakers and spinnakers.

In both cases, the marriage of the semi-elliptical shape to an in-place roller furling headsail finally brings to the market a long-awaited synergy at low incremental cost over conventional triangular headsails with their inherent limitations.

Sail inventory and its cost are reduced significantly by the versatility and durability of the said elliptical sails, and important gains in safety and convenience are achieved. Specific advantages of the present invention for horizontally deployed headsails may be allocated between:

a. elliptical roller furling genoas **convertible to true self-tacking working jibs**; and

b. maximum surface elliptical roller furling genoas **capable of replacing free-flying headsails.**

The combination of in-place roller furling means and a semi-elliptical sail having a supported positive roach was heretofore considered unattainable. The present invention brings a unique combination of elements to both the abovementioned types of horizontally deployed sails.

c. **The convertible genoa - self-tacking working jib** takes advantage of its unique combination of maximum positive foot curve and its maximum roach to yield sufficient surface area and maximum efficiency when furled to self-tacking configuration. When fully deployed, the said sail provides far greater surface area and efficiency than a triangular sail of like foot length, or overlap.

Thus, the convertible genoa- working jib comprised by the present invention meets and exceeds minimum performance requirements over a wide range of wind and sea conditions. Such versatility in a single triangular sail does not exist.

d. Since conventional triangular furling genoas cannot meet such performance requirements, they are ineffective except in medium to heavy winds. More importantly, such conventional triangular genoas quickly lose a correct sheeting angle as they are furled.

The said convertible elliptical genoa-working jib, when unfurled provides power and convenience far in excess of a triangular sail of equivalent foot length and, indeed, even one having equivalent surface area. Such a semi-elliptical furling headsail has a shorter foot than a triangular sail of equivalent surface area, and is thus more quickly deployed and recovered, all the while reducing heel, thus providing greater driving force and comfort.

A triangular sail of equivalent surface area has a longer foot and is more difficult to deploy and recover. In addition, it would provide an inferior interface with its companion mainsail due to greater overlap. Finally, a triangular furling sail does not have the control and stability attributes inherent in the semi-elliptical form and battens or batten substitute means comprised by the present invention.

MAXIMUM SURFACE SEMI-ELLIPTICAL ROLLER FURLING GENOA FOR REPLACING FREE-FLYING HEADSAILS.

The subject semi-elliptical headsail replaces spinnakers and gennakers while eliminating the added equipment and danger that accompany the use of such sails.

The said semi-elliptical headsail comprises positive foot and roach

dimensions that make possible simultaneously, adequate surface area, increased efficiency, increased sail stability, and correct sheet lead angles. These advantages maintain over a greatly increased range of wind and sea conditions, as compared to triangular furling headsails.

The versatility of conventional triangular headsails is severely limited as compared to the said maximum surface semi-elliptical furling sail. Moreover, the said semi-elliptical sail is more stable by virtue of its batten or batten substitute means and semi- elliptical form.

The said semi-elliptical form reduces heeling effect, and delivers the performance benefits discussed above in connection with elliptical working jibs. The said advantages maintain as the said sail is furled, or reefed. All such advantages are gained at a small incremental cost to conventional triangular genoas. The reduction in heeling forces translates directly to forward drive and less violent boat movement. This quieting of boat movement further enhances sail stability in variable conditions.

Since the said semi-elliptical sail is permanently in place, the danger of on-deck sail handling is eliminated entirely, along with stowage problems. Spinnaker socks were developed in hopes of overcoming the sail handling disadvantages of such free-flying sails.

What the market sought in spinnaker socks was safety and convenience, but once a spinnaker is contained by the sock, it must still be lowered and stowed, then hoisted again each time conditions change. Such sails cannot compare with in-place headsails in terms of safety and convenience. The difficulty of deploying, controlling, and recovering such sails gives a clear advantage to the semi-elliptical in-place headsails of the present invention in average boat speed.

In the final analysis, market demand for safety and convenience can be achieved only by eliminating on-deck sail handling entirely. The present invention achieves this objective for the first time in conjunction with an

in-place semi-elliptical headsail whose overall performance rivals or exceeds free-flying sails.

Both versions of the said semi-elliptical roller furling headsails are more stable than their triangular counterparts by virtue of their shape and roach support means, thus affording not only more constant propulsion in difficult wind and sea conditions, but greater durability due to reduced vibration or flogging.

Whether vertically or horizontally deployed, the sails that comprise the present invention deliver increased comfort due to decreased heeling and shorter passage times. The ease of maintaining the elusive "right sails at the right time" typically provides faster average speeds than those produced by a tired crew, even where free-flying sails are used.

SYNERGY OF THE SAID SAILS FOR TWIN HEADSTAY RIGS

In addition to the abovementioned synergy between the present invention's headsail form and mainsails, a particular advantage applies when both an inner and outer semi-elliptical sail is used downwind on twin headstay rigs.

Proponents of free-flying sails often allude to the fact that such sails present their surface both to port and starboard of the headstay. This is undeniable, as are the control difficulties and frequent on-deck sail handling requirements such sails impose in order to meet changing wind and sea conditions.

These disadvantages are markedly absent when an in-place semi-elliptical working jib is deployed to one side and an in-place elliptical furling genoa to the other. Balanced sail area is presented on either side of the headstay. Control and reduction of this balanced sail area is achieved from the cockpit. No poles, socks, or other costly and potentially dangerous sail handling equipment is involved.

Finally, by combining a maximum surface furling genoa on the forward stay with a vertically or horizontally deployed semi- elliptical working jibon the inner stay, maximum benefits can be gained.

A vertically deployed semi-elliptical working jib is stable by virtue of its self booming and vanging and is reefed from the cockpit. Going to the furling alternative, a horizontally deployed convertible elliptical genoa-working jib can cover a wide wind range, thus allowing the forward sail to correspond to a more specific light wind range. In either case, use of the two sails in harmony for downwind sailing presents true synergy of result in a balanced, easily handled configuration.

The efficient form of each such sail reduces the tendency of the boat to roll and yaw. Discomfort and seasickness is decreased, as is wear on sails and rig. Increased boat stability reduces demands on the helmsman, or autopilot, as the case may be, and safety is materially improved in difficult conditions. Most important, deployment, reefing, and recovery of this versatile and powerful replacement for free-flying sails is accomplished from the safety of the cockpit. This combination of advantages is both unique and unexpected.

Spinnakers and gennakers cannot be reefed. They must be lowered when conditions pass their design limits, then stowed, then re-hoisted each time conditions allow and crew motivation permits.

The stability of the said in-place semi-elliptical sails in the above configuration, commonly referred to as "wing-and-wing," eliminates the cost, effort and danger that accompany whisker or spinnaker poles. Supposedly, asymmetric spinnakers, can be flown without a pole. This is simply not the case when sailing dead downwind, where such sails are prone to repeated collapse-violent refill cycles. In contrast, the downwind rig comprised by the present invention is stable and powerful when sailing dead downwind.

The said wing-and-wing configuration can be sailed dead downwind

without poling out the elliptical genoa, particularly where the self-boomed elliptical working jib is used. In this case, boat heading can favor the furling genoa, leaving the jib supported and controlled by its integral booming and vanging. The said jib has little tendency to jibe in such circumstances, and even if it does, no harm or inconvenience is occasioned. This is entirely different from the on-deck sail handling required by an emergency takedown of a spinnaker, its pole and related sheets and guys in heavy weather conditions.

Perhaps the most significant benefit of the said semi-elliptical wing-and-wing configuration is its ability to propel the boat with little or no mainsail exposed, even in lighter winds. Eliminating the mainsail and boom from downwind navigation marks significantly increased boat safety and stability. Where the mainsail promotes rounding up or even broaching, the downwind configuration of the present invention does the contrary. Each sail counter balances the other, with forward motion the result. The fact that both headsails have a stable form and integral control means improves boat stability markedly over conventional triangular sails in a wing-and-wing configuration.

The lesser efficiency and stability of triangular sails has limited their marketability for light air downwind use over the years, even in various wing-and-wing guises. The present invention, for the first time, makes high performance downwind sailing without on-deck sail handling a reality.

Asymmetric spinnakers and other approaches to this problem simply do not realize this unique reconciliation of performance, safety, cost and convenience.

LOWER COSTS AND HIGHER PROFIT MARGINS IN SAIL AND SAILBOAT CONSTRUCTION

The present invention, by virtue of the increased efficiency and surface

area of its semi-elliptical headsails, offers economies to sail makers and boat builders alike by making possible equivalent power with shorter rigs and lighter keels, or alternatively, providing significant marketing advantages via increased performance without increasing mast height, ballast specifications or construction costs.

The automatic stowage component of the present invention offers the further cost and marketing advantage of on-board sizing of the jib cover, which can facilitate reductions in the final price of the said cover. In addition, such on-board sizing of the said automatic stowage cover leads naturally to sale by mail order, internet and other such means. Thus, even lower costs can be achieved through increased market penetration.

SUMMARY OF OJECTS AND ADVANTAGES

The first headsails were hoisted and lowered. Later, furling sails appeared, and a choice between vertically deployed and horizontally deployed sails was possible. As a general rule, it has been accepted that a vertically deployed sail performs better than a counterpart horizontally deployed sail, but that the latter sail offers greater versatility and ease of use. It has also been urged that one horizontally deployed sail can replace several vertically deployed sails. In fact, true versatility in furling sails has remained unattained.

Whether vertical or horizontal sail deployment is chosen, a conventional triangular sail deployed in either manner has significant limitations, some common to both deployment means, some particular to one or the other:

a. As wind strength increases, and a headstay sags, the attached sail becomes fuller. This is the opposite of what is desired.

b. Conventional headsails fixed to stays have been triangular in shape. This is the opposite of what is desired.

c. Reefing of horizontally deployed conventional headsails seriously compromises correct sheet angles and efficiency of the partially furled, or reefed sail.

d. Reefing of conventional vertically deployed headsails is hazardous, and the results are unsatisfactory.

e. The conventional triangular sail, whether vertically or horizontally deployed, invites the greatest possible impediment to efficient propulsion: Induced Drag. Simply stated, the air on the windward side of a sail is high-pressure air, and the air on the leeward side is low-pressure air. The leakage of high-pressure air over the head or below the foot of a sail is induced drag, which produces turbulence and reduces driving force

Tom Whidden, President of North Sails, in a leading book on sail design, confirms the foregoing observations in commenting on the optimum shape for a sail, and on the merits of vertically deployed and horizontally deployed sails "The Art and Science of Sails" (T. Whidden, St. Martin's Press, 1990).

First, as to optimum sail shape, Mr. Whidden noted that, "[The] famous RAF Spitfire airplane determined that the optimum profile for a wing…is an ellipse---U-Shaped. **The worst shape for an airfoil is a triangle, the shape of a headsail and, to a lesser extent, the main.**

Following this to its logical conclusion: **Why not make the headsail more like a main? Shouldn't that provide the best of all worlds?"**

As for the merits of vertically and horizontally deployed sails, Mr. Whidden states that, " …the difference between up and down and in and out may not seem that substantial. [It] is. **At the end of the day**

[vertically deployed sails] have to be furled and covered with a sailcover.

OBJECTIVES OF THE PRESENT INVENTION

The present invention, for the first time, brings to both horizontally deployed and vertically deployed headsail systems major cost and operational benefits in the absence of overriding disadvantages, regardless of which sail deployment method is chosen. Known sails do not even approach the objective of the present invention.

This achievement required that specific advantages and disadvantages be identified, that the most serious problems be isolated, and solutions developed. After years of testing and evolution, the subject sail system comprises unique horizontally deployed sail forms and configurations, unique vertically deployed sail forms and configurations, plus an automatic stowage means which makes stowage of vertically deployed jibs as safe and convenient as stowage of furling sails. Thus, the present invention provides a choice of deployment methods without compromising on the one hand efficiency, and on the other, ease of deployment, reefing , recovery, or stowage.

The present invention makes going faster a safer, easier, and less costly process than heretofore, when faster equated to more effort, cost and risk. The benefits of the present invention not only affect performance and ease of use, but extend to safety, cost effectiveness, and beyond, as discussed below.

Along with the foregoing, the present application includes:

a. a description of the of drawings of the present invention and a description of its operation;
b. a description of the main and alternative embodiments of the present invention;
c. a list of reference numerals; and

d. three main claims and seventeen dependent claims

LIST OF REFERENCE NUMERALS

forestay 18
inner forestay 19
genoa halyard 20
jib halyard 21
semi-elliptical roller-furling convertible genoa-jib 22
vertically deployed semi-elliptical sail 22B
semi elliptical self-tacking jib 23
roller-furling semi-elliptical convertible inner genoa-jib 23A
lower jib batten pocket 24A
lower jib batten pocket 24B
mainsail 25
upper jib battens 25A
upper jib battens 25B
upper jib battens 25C
upper jib batten pocket 26A
upper jib batten pocket 26B
upper jib batten pocket 26C
reef point 27A
reef point 27B
jib downhaul 28
Dutchman control lines 29A, 29B
jib reef line 30
mast 34
backstay 36
jib sheet 37
boom 38
lower round diagonal jib batten 38A
intermediate round diagonal jib batten 38B
roller-furling forestay mechanism 40
batten-substitute means 41
genoa batten 41A

genoa batten 41B
genoa batten 41C
leech taping 41D
roach stiffening junction 41E
roller-furling inner forestay mechanism 42
strop 43
automatic jib stowage bag 44
automatic stowage bag solar panel 44A
automatic semi-rigid sail stowage bag 45
semi-rigid lower stowage means section 45A
fabric upper stowage means section 45B
automatic mainsail stowage bag 46
genoa sheet 47
genoa batten pockets 49A
genoa batten pockets 49B
genoa batten pockets 49C
main sheet. 50
lower jib batten box 65
lower jib batten box 65A
intermediate jib batten box 66
intermediate jib batten box 66A
central bag section 72
forward bag closure extension 74
aft bag closure extension 76
central bag section stay cutout 77
upper batten pocket 78
upper batten pocket 78A, 78B, 78C, 78D
bag extension batten pockets 79
lower batten pocket 80
lower batten pocket 80A
central bag batten pocket 82
central round batten 83
batten closure flap 85
lower bag batten 86
lower bag batten 86A

upper bag flexible tube 88
upper bag flexible tube 88A
removable fixing means 89
removable fixing means toggle 89A
lower batten flexible tube 90
lower batten flexible tube 90A
attachment point 94
drain hole 95
forward bag lower flexible tube support 96
aft bag lower flexible tube support 98
flaked sail 100
control line 102
control line 102A
clew ring 104
topping lift 106
Dutchman tab 108
Dutchman tab 108A
forward bag lateral support means 110
forward bag lateral support means 110A
forward bag central support means 112
aft bag lateral support means 114
aft bag lateral support means 114A
aft central support means 115
bag upper batten closure means 116
jib lazy jacks 118
Dutchman control lines 120, 120A
roller-furling cargo boom 124
horizontally deployed semi-elliptical furling mainsail 125
vertically deployed semi-elliptical mainsail126
headboard end-plate means 126A
upper mainsail sheet 128

DESCRIPTION OF DRAWINGS

1. **Figure 1** is side view of a cutter-rigged sailboat carrying a, semi-elliptical convertible genoa-jib, and a vertically deployed semi-elliptical self-tacking headsail, according to the present invention.

2. **Figure 1A** is a side view of a cutter-rigged sailboat carrying a fully-unfurled semi-elliptical convertible genoa-jib, according to the present invention.

3. **Figure 1B** is a side view of a cutter-rigged sailboat carrying a vertically deployed semi-elliptical self-tacking jib on an inner forestay, according to the present invention.

4. **Figure 1C** is a side view of a cutter-rigged sailboat carrying a vertically deployed semi-elliptical self-tacking jib and automatic jib stowage bag on an inner forestay and a horizontally deployed semi-elliptical mainsail, according to the present invention.

5. **Figure 1D** is a side view of a sloop-rigged sailboat carrying a vertically deployed or non-furling semi-elliptical overlapping headsail, according to the present invention.

6. **Figure 2** is an overhead view of an automatic jib stowage bag, according to the present invention..

7. Fig**ure 2A** is an overhead view of the flexible tube to batten union of the said automatic jib stowage bag, according to the present invention.

8. **Figure 2B** is a perspective view of the forward section of the said jib stowage bag and its forward bag closure extension, according to the present invention.

9. **Figure 3** is a perspective view of the said automatic jib stowage bag in an open and raised configuration, according to the present invention.

10. **Figure 3A** is a perspective view of the said automatic jib stowage bag in a closed configuration, according to present invention.

11. **Figure 3B** is an overhead view of the said automatic jib

stowage bag in a navigation configuration, showing its closure means, according to the present invention.

12. **Figure 3C** is a side view of the said automatic jib stowage bag and its support means in a lowered-for-navigation configuration, according to the present invention.

13. **Figure 3D** is a perspective view of an alternative embodiment of an automatic jib stowage bag in an open and raised configuration, according to the present invention.

14. **Figure 3E** is a perspective view of an alternative embodiment of an automatic jib stowage bag in a closed configuration according to the present invention.

15. **Figure 4A** is a side view of a sailboat carrying a vertically deployed semi-elliptical self-tacking jib with a patented Dutchman sail control system, an automatic jib stowage bag, and an automatic mainsail stowage bag, according to present invention.

16. **Figure 4B** is a side view of a sailboat carrying a semi-elliptical self-tacking jib with a lazy jacks sail control system, an automatic jib stowage bag, and an automatic mainsail stowage bag, according to the present invention.

17. **Figures 5A, 5B, and 5C** each show a side view of a sailboat carrying a semi-elliptical convertible genoa-jib on its headstay in progressively furled configurations, according to the present invention.

18. **Figures 6A, 6B, and 6C** each show a side view of a cutter-rigged sailboat carrying a roller furling semi-elliptical inner convertible genoa-jib on its inner headstay in progressively furled configurations.

19. **Figures 7A through 7D** each show side views of a sailboat with different versions of a semi-elliptical convertible genoa-jib attached to roller-furling headstay means. Each such version is depicted in progressively furled configurations, according to the present invention..

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20. **Figures 8A and 8B** depict additional embodiments of the present invention as applied to a large, three-masted vessel in the form of both headsails and mainsails, according to the present invention.

DESCRIPTION OF PREFERRED EMBODIMENT

FIGURE 1.

Fig. 1 is a side view of a double-headsail sail system, according to the present invention, installed on a double headsail or cutter-rigged sailboat. The said sailboat has a standing rig comprising a forestay 18, around which revolves a conventional roller-furling system 40, comprising an extrusion and upper and lower swivels (not shown individually). The standing rig further comprises an inner forestay 19, a plurality of side stays which are not shown, a backstay 36, a mast 34 and a boom 38

The sailboat carries a semi-elliptical convertible genoa-jib 22 on its forestay 18 and a semi-elliptical vertically deployed self-tacking jib 23 on its inner forestay 19. The said self-tacking jib is controlled during hoist and drop by a Dutchman patented sail control system (U.S. patent no. 4,688,506, M. Van Breems, Sep. 3, 1985). Details of the said automatic jib stowage bag and the said Dutchman control system are shown in subsequent figures.

FIGURE 1A. THE SEMI-ELLIPTICAL CONVERTIBLE GENOA-JIB

The forward most component of the present invention is a convertible

semi-elliptical roller-furling genoa-jib 22 which is attached to the forestay 18 by means of a conventional roller-furling forestay mechanism 40 comprising upper and lower swivels and an extrusion which passes over the said headstay 18. The genoa head is attached to the upper swivel of the said roller-furling mechanism, which is attached to a genoa halyard 20 which runs from the said upper roller-furling swivel to the mast halyard entry box (not shown) and thence to the mast exit box and cleat. The genoa foot is attached to the lower swivel of the conventional roller-furling mechanism, and the genoa clew is attached to a genoa sheet 47, which leads to the cockpit via conventional genoa cars which slide along a deck track (not shown).

The sail shown in figure 1A is constructed by gluing or sewing together panels of sail cloth materials. Alternatively, the said sail may be constructed using known and patented methods such as North 3-D, Sobstad Genesis, or Tape Drive, in which the sail is constructed as single entity or fused into a single entity by such processes.

The said sail may be constructed of material of uniform weight and resistance, or it may comprise progressive weight and resistance. The material situated aft of the head to clew line comprises positive roach, resulting in a semi-elliptical shape. The material situated below a line from foot to clew comprises positive roach.

For purposes of comparison, a line running from the clew to the head of the said sail delimits the surface area of a conventional triangular sail. Where appropriate, such a line is included in drawings of the present invention. This line need not appear on an actual sail.

The said positive roach is supported by a plurality of battens 41A, 41B, and 41C, which are contained by batten pockets 49A, 49B,and 49C, each of which is closed at its upper end by conventional means and which has conventional batten pocket closures at its lower en, typically secured by hook and loop fastening means. Details of the batten pocket and pocket closures shown in figure 1A are discussed below.

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The said battens may run from the leech to the foot of the sail, as shown in figure 1A, or they may be shorter. In either case, the said battens must be at least long enough and sufficient in number to support the positive roach of the sail in the design wind range of the said sail.

As a general rule this requires a batten at least twice as long as the distance from the triangular demarcation of the sail to the extremity of the leech, each such batten running parallel to the luff of the said sail.

Additional stiffening of the positive roach of the said sail is provided first, by semi rigid leech taping 41D, comprising Mylar ™ or other commercially available material whose physical properties rigidify the leech curve while, at the same time, allowing the said genoa to be furled, or folded for eventual storage.

Second, roach stiffening junctions 41E run between the batten pockets. The said stiffening junctions comprise bands of Mylar ™ or other semi-rigid material having characteristics similar to the said leech taping material.

The said sail may employ additional features not shown separately such as leech and foot lines, draft stripes, ultra violet-resistant foot and luff bands, foam or cordage furling aids, telltales, anti chafe protection, and tacking rings.

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FIGURE 1B. THE SEMI-ELLIPTICAL SELF-TACKING JIB

Next aft is a semi elliptical self-tacking jib 23, which is constructed using methods and materials described in the immediately preceding paragraph. The said jib is connected at its head to a jib halyard 21, at its clew to a jib sheet 37, and at its tack to the deck by means of a strop 43. The upper battens of the said jib are attached to the inner forestay 19 by conventional hanks, which are not shown, and the two lower battens are attached to the said inner forestay by two fork end batten box terminal

fittings (not shown).

The lower part of the jib, delimited by the foot of the said jib and intermediate round diagonal jib batten 38B is attached to the inner forestay 19 as follows:

The forward or luff ends of lower round diagonal jib batten 38A and intermediate round diagonal jib batten 38B are contained by lower jib luff batten boxes 65A and 66A respectively.

The said jib luff batten boxes incorporate conventional integral threaded tangs, or fork terminals, at their forward ends for attachment to the inner forestay 19. Jib leech batten boxes 65B and 66B contain the aft ends of the said round diagonal intermediate and lower jib battens.

A line drawn from the center of each luff batten box to its companion leech batten box forms a right angle with the luff of the said jib. The batten boxes are attached to the jib by conventional means.

Lower jib batten pockets 24A and 24B contain that portion of the said round lower and intermediate round diagonal jib battens not contained by the said jib batten boxes. Fixed to the said sail are a plurality of upper jib batten pockets attached at right angles to the luff of the said jib, comprising upper jib batten pockets 26A, 26B, and 26C.

Inserted into each of the said upper jib batten pockets is a like number of upper jib battens 25A, 25B, and 25C each of which is retained at its luff and leech end by conventional batten retention means which are not shown. The said upper jib battens are more flexible than the said lower jib battens, and may be either flat or round. The said battens are fixed perpendicular to the luff of the said sail in the preferred embodiment.

A jib reefing line 30 runs from the clew of the said jib through jib reef point 27B to jib reef point 27A, or via pulleys fixed to the said reef points, then down to a deck pulley (not shown), thence to the cockpit.

A jib downhaul (not shown) runs from an eyelet in the luff of the said sail just below its head to a conventional deck pulley (not shown) at the foot of the inner forestay 19, thence to the cockpit.

<u>FIGURE 1C. THE AUTOMATIC JIB STOWAGE BAG. SIDE VIEW</u>

Figure 1C is a side view of the said sailboat showing an automatic jib stowage bag 44 in a lowered, ready-for-navigation configuration. The semi-elliptical self-tacking jib 23 is shown hoisted, with the said jib stowage bag in a low-profile navigation configuration at the level of the foot of the said sail.

<u>FIGURE 1D. A VERTICALLY DEPLOYED SEMI-ELLIPTICAL GENOA. SIDE VIEW</u>

<u>Figure 1D</u> shows a vertically deployed semi-elliptical genoa 22B attached to a conventional forestay extrusion by a bolt rope, or to a headstay by hanks. The said genoa employs the said roach stiffening means 41D and roach stiffening junctions 41E.

<u>FIGURE 2. THE AUTOMATIC JIB STOWAGE BAG. OVERHEAD VIEW</u>

<u>CONSTRUCTION DETAILS</u>

Figure 2 is an overhead view of automatic jib stowage bag 44. In the preferred embodiment, the said bag is constructed of cloth panels sewn together. The bag comprises three major parts:

1. **<u>The central bag section 72</u>**, whose length exceeds the foot length of the sail (shown below in figures 3 and 3A) to be contained therein. The total length of the said central section approximates the sum of the said sail's foot length plus its widths, fore and aft with the said sail in a lowered, flaked configuration.

2. Attached to the fabric of central bag section 72 are five batten pockets comprising lower bag batten pockets 80 and 80A, upper bag batten pockets 78and 78A, and central bag batten pocket 82, each of which is constructed of cloth and attached to the said central section.
3. Each of the said pockets is attached to the same surface of central bag section 72, which surface will be the interior surface of automatic jib stowage bag 44 when the said bag is closed. Individual pockets are attached to the central bag section 72 as follows:

Upper batten pocket 78 is open at both ends and is attached to central bag section 72 along its left-hand or port extremity (situated at lower extremity of figure "2").

Lower batten pocket 80 is open at both ends and is attached to the central bag section parallel to upper batten pocket 78 along a line approximately midway between the port extremity of the central bag section 72 and its centerline.

Upper batten pocket 78A and lower batten pocket 80A are open at both ends, and each is approximately 5 cm. shorter than that part of central bag section 72 to which they are attached. Each of the said pockets is centered with respect to the ends of the central bag section.

Four identical **batten-tube closure flaps 85** are attached to the port section of central bag section 72 at the forward and aft extremities of upper batten pocket 78 and lower batten pocket 80. Each such closure flap is sewn to the central bag section on one edge in the fore and aft line of its companion batten pocket. The said closure flaps possess l closure means such as hook and loop strips, attached to the said flaps.

Central bag batten pocket 82 is centered on the inner surface of the central bag section 72 along a line running from the center point of the forward end of the said central bag section to the center point of the aft end of the central bag section. The said central bag batten pocket is approximately 10 cm. shorter than the foot of the sail to be contained.

An upper batten 84, lower batten 86, lower batten 86A, upper batten 84A, and a central batten 83 are contained in each of upper batten pocket 78, lower batten pocket 80, lower batten pocket 80A, upper batten pocket 78A and central batten pocket 82. Each such batten is a round batten somewhat shorter than the foot of the sail to be contained by the said automatic jib stowage bag 44, unless the said central batten is to serve as a boom, as discussed below under "alternative embodiments".

2 & 3. Forward bag closure extension 74 and aft bag closure extension 76 comprise the second and third sections of the said bag. The width of each of the said bag closure extensions is approximately 30 cm. greater than the respective fore and aft widths of the said loosely flaked sail, as shown below in figures2, 3 and 3A. Details of the said bag closed around the said flaked sail are shown in figures 3 and 3A below.

Since the circumference of the loosely flaked sail to be contained is somewhat greater at the forward end of the sail than the aft end, the width of the said central bag section 72 will be somewhat greater, relatively, at the forward end than the aft end.

UNION OF FLEXIBLE TUBES TO BATTENS

Flexible tubes 88, 88A, 90 and 90A encase companion upper and lower round battens contained in the starboard part of the central bag section 72 as shown in figure 2.

Specifically, the forward ends of upper batten 84A and lower batten 86A will be encased by forward flexible batten tubes 88 and 90, respectively.

The aft ends of the said upper batten 84A and lower batten 86A will be encased by aft batten flexible tubes 88A and 90 A respectively,

The four said flexible batten tubes enclose the said round battens snugly. Each such flexible tube will be placed over its respective round batten in such a manner that approximately 10 cm. of each such tube extends beyond the end of each such round batten toward its center. Fixing means such as a pin will fix the said companion round battens and flexible tubes to each other as shown in a subsequent figure.

Identical **bag attachment points 94** made of webbing or other such material are placed as shown in Figure 2 at a plurality of points on the automatic jib stowage bag 44.
A plurality of **drain holes 95** is cut into the said central section with appropriate reinforcing (not shown), or the said central section may be composed of mesh material (not shown)

.

Flexible tube support straps 96 and 98 comprising a durable semi rigid material are attached by conventional means at the midpoint of and perpendicular to the lower extremity of each of the said closure extensions as shown in Figure 2. The said attachment point is adequately reinforced (not shown).

BAG CLOSURE MEANS

Closure means 116 (shown in a subsequent figure) comprising material such as hook and loop flaps or pressure snaps are placed at a plurality of points along the upper extremities of the central bag section 72. Such closure means are also placed at a plurality of points along the after most extremity of forward bag closure extension 74, and along the forward most extremity of aft bag closure extension 76.

FIGURE 2A. BATTEN TO FLEXIBLE TUBE UNION. PARTIAL OVERHEAD VIEW

Figure 2A is a partial overhead view of the said automatic stowage bag showing the details of the union of the forward part of upper batten 84,

upper batten 84A, and upper batten flexible tube 88. The said battens and each end of the said flexible tubes are drilled to accept a removable fixing means 89, secured by I means such as an integral toggle 89A. The said fixing means pass through the holes in the said battens and flexible tubes and secured by the said integral toggles.

In like manner, but not shown, the after end of upper battens 88 and 84A are joined to upper batten flexible tube 88A . Lower batten 86 and lower batten 86A are joined to lower batten flexible tube 90 forward and to lower batten flexible tube 90A aft in like manner (not shown), to form an upper unity and a lower unity, as seen in Figure 3 below.

FIGURE 2B. FORWARD BAG CLOSURE EXTENSION. PARTIAL PERSEPCTIVE VIEW

Figure 2B is a partial perspective view of the forward part of automatic jib stowage bag 44 showing the forward bag closure extension 74 as it appears in an open position (shaded), then in a closed position (unshaded). The two forward extension closure flaps 85 are visible at the starboard forward upper flexible tube to batten union and at the lower batten to flexible tube union. As shown in figure 2 above, two additional closure flaps are attached at the aft ends of the said upper and lower batten pockets. Not shown are the aft counterparts of the foregoing.

FIGURE 3.

AUTOMATIC JIB STOWAGE BAG 44 SAIL CONTROL MEANS

Figure 3 is a perspective view of automatic jib stowage bag 44 encircling a folded or flaked sail, in this case a semi-elliptical self-tacking jib 23, whose clew ring 104 is attached to a topping lift 106. The said topping lift comprises cordage and is connected to the forward surface of the mast at a point above the head of the sail (not shown).

The said jib is provided with a patented Dutchman control system comprising two Dutchman tabs, 108 and 108A, as well as a series of eyelets in the sail and Dutchman control lines, as shown in **figure 1** above and **figure 4A** below. The said control lines attach to topping lift 106 using the attachment means described in the said Van Breems patent as detailed in **figure 4A** below.

FIGURE 3A. AUTOMATIC JIB STOWAGE BAG IN CLOSED POSITION PERSPECTIVE VIEW

Figure 3A is a perspective view of automatic jib stowage bag 44 showing the said bag in a closed position with the flaked sail enclosed therein. The upper extremities of the said bag are secured by a plurality of the abovementioned closure means 116.

FIGURE 3B. AUTOMATIC JIB STOWAGE BAG. OPEN POSITION OVERHEAD VIEW

Figure 3B is an overhead view of automatic jib stowage bag 44 in an open, ready-for-navigation configuration. The upper batten to upper flexible tube assembly as contained by upper batten pocket 78 and upper batten pocket 78A is lowered onto the lower batten to lower flexible tube assembly as contained by lower batten pocket 80 and lower batten pocket 80A. Not shown is an alternative configuration in which the said upper section is folded over and below the said lower assembly, and secured at or just below the foot of the said jib. In either case, the upper and lower sections are secured to each other by a plurality of closure means 116.

Upper bag flexible tubes 88, forward, and 88A, aft, and the upper battens they encase have been squeezed close to each other, and the upper batten to flexible tube unity has been secured by its plurality of closure means 116 at the level of or just below the foot of the said jib.

FIGURE 3C. AUTOMATIC JIB STOWAGE BAG. OPEN POSITION PERSPECTIVE VIEW

Figure 3C is a perspective view of automatic jib stowage bag 44 in an open, navigation configuration. The said upper unity has been folded downward and over the said lower unity, thus comprising the lowest extremity of the said bag. The round battens comprising the said upper unity and lower unity have been secured to each other by a plurality of closure means 116.

The said bag is attached to the inner forestay 19 at its forward end and to the topping lift 106 at its aft end. In both cases the said attachment is by means of three attachment points, a central flexible tube attachment point (94 forward and 96 aft) and port and starboard lateral attachment points 94 each attached to the said bag.

The three attachment points at each end of the said bag are joined to the inner forestay or the topping lift, as the case may be, by three attachment means, central, port and starboard, comprising cordage or webbing, thus forming a triangular attachment of the forward end of the said bag to the inner forestay 19, and of the aft end of the said bag to the topping lift 106.

A detailed description of the attachment of the forward end of the said bag to the inner forestay 19 and of the attachment of the aft end of the said bag to the topping lift 106 follows.

Forward, flexible tube support means 96 of the said bag is connected to the inner forestay 19 by forward central support means 112. The counterpart port and starboard forward lateral attachment points 94 of the said bag are attached to the inner forestay by forward port and starboard lateral support means 110 and 110A comprising cordage or webbing. The said central and lateral support means are attached to the said inner forestay by means of knots or snap hooks to a ring fixed to the said inner forestay (not shown). The detail of this triangular attachment

of the attachment points of the said bag to the said inner forestay are shown in the inset above drawing 3C.

Aft, flexible tube support means 98 is attached to topping lift 106 by aft central support means 115. Aft port and starboard lateral attachment points 94 are attached to topping lift 106 by means of port and starboard aft lateral support means 114 and 114A, comprising cordage or webbing. The said aft support means are each attached to topping lift 106 by knots or snap hooks to a ring fixed to the said topping lift. Detail of the connection between the aft attachment points of the said bag and the said topping lift correspond to that shown in the inset depicting details of the forward attachment points.

Drawing 3C depicts the said fore and aft central and lateral support means suspending the said bag in its lowered, navigation configuration at approximately the level of the foot of the companion sail.

FIGURES 3D & 3E. ALTERNATIVE EMBODIMENTS OF AUTOMATIC JIB STOWAGE BAG.

Figures 3D & 3E show an automatic jib stowage bag comprising a semi-rigid lower section and a fabric upper section, .

The said lower section is constructed of semi-rigid material in three parts, a longitudinal section, and two end caps. The three components are joined by attaching means such as rivets, or threaded attachment means (not shown), and the resulting lower section is referred to collectively as **semi-rigid lower stowage means section 45A.**

The said upper section is constructed of fabric in conformity to construction of the upper section of automatic jib stowage bag 44 seen in **figure 2**. The said upper section is referred to as **fabric upper stowage means section 45B.**

The said upper and lower sections are joined using methods such as

rivets, or by incorporating a channel into the said lower section to receive a bolt rope attached to the said upper section (not shown).

This alternative embodiment also comprises a semi-rigid mainsail stowage bag. The means for attaching such a bag to a mast and boom correspond to the attachment means discussed above in connection with automatic mainsail stowage bag 46.

Also shown in figure 3D and in Figure 3E are stowage bag solar panels 44A, which panels, at their upper extremities have been hinged to the fabric of the upper section of the said bag, and which panels are attached at their lower extremities with removable closures (not shown), thus allowing orientation of the said solar panels to the sun. The said solar panels would be attached to automatic jib bag 44, or automatic mainsail stowage bag 45, the all fabric versions, in a like manner. In the event attachment to a rigid lower section ws appropriate, such attachment would employ methods and materials appropriate to the material of the said semi-rigid lower section, as opposed to a fabric section.

FIGURE 4A. SEMI –ELLIPTICAL SELF-TACKING JIB WITH DUTCHMAN

SIDE VIEW

Figure 4A is a side view of the said cutter rigged sailboat showing the said semi elliptical self-tacking jib 23 in a raised or hoisted configuration. A plurality of patented jib Dutchman control lines 120 and 120A pass through a plurality of patented Dutchman eyelets in conformity to the said Dutchman patent.

The upper end of each of the said Dutchman sail control lines is attached by patented Dutchman attachment means to the topping lift 106, and the lower end of each control line is attached to its corresponding patented

Dutchman tab, 108 and 108A, as shown in Fig. 3.

The said automatic jib stowage bag 44 is shown in its navigation configuration and is attached as shown in figure 3C above.

Also shown is a semi-elliptical mainsail 25 contained on either side by mainsail lazy jacks 28. An alternative embodiment of the said automatic jib stowage bag 44 is shown attached to the said main boom and mast. This embodiment comprises a mainsail automatic stowage bag 46.

An alternate mainsail control system comprising the said patented Dutchman sail control system is not shown. Both the said mainsail and jib stowage bag may incorporate a stowage bag solar panel, 44A (not shown).

FIGURE 4B.SEMI-ELLIPTICAL SELF-TACKING JIB WITH LAZY JACKS SIDE VIEW

Figure 4B is a side view of the said cutter-rigged sailboat showing the said raised or hoisted semi elliptical self-tacking jib 23. In this figure the said jib is contained on either side by jib lazy jacks118, which are attached to the foot of the said sail and to the mast, aloft, at a point near the head of the sail. The said jib lazy jacks are assembled of cordage in a manner similar to that used for mainsail lazy jacks.

The said automatic jib stowage bag is attached to the said inner forestay forward and to the said topping lift aft as detailed in figure 3C above. The automatic jib stowage bag 44 is shown in its navigation configuration

.

Also shown is a semi-elliptical mainsail 25 contained on either side by conventional mainsail lazy jacks 28. An alternative embodiment of the said automatic jib stowage bag 44 is shown attached to the said boom and mast. This embodiment comprises an automatic mainsail stowage bag 46. An alternative mainsail control system comprising the said

patented Dutchman sail control system is not shown. Both the said mainsail and jib stowage bags may incorporate stowage bag solar panels, 44A.

FIGURES 5A, 5B, and 5C. SEMI-ELLIPTICAL ROLLER-FURLING CONVERTIBLE GENOA – JIB. SIDE VIEW

Figure 5A is a side view of a sloop-rigged sailboat carrying a semi-elliptical roller-furling convertible genoa-jib 22 in fully unfurled configuration. The foot length of the said headsail approximates that of a 150% triangular genoa for such a boat. The construction of the said convertible genoa-jib was specified in Figure 1. The clew of the said genoa-jib is attached to genoa sheets 47, which lead to the cockpit of the said sailboat via spinnaker blocks at each quarter.

Figure 5B is a side view of the said sailboat of Figure 5A with the said convertible genoa-jib partially rolled or furled to approximately the foot length of a 135% triangular genoa. Genoa batten 41A has been rolled around the roller-furling forestay mechanism 40. The clew of the said genoa-jib is attached to genoa sheets 47 which lead to the cockpit of the said sailboat via genoa cars on each side of the said sailboat.

Figure 5C is a side view of the said cutter-rigged sailboat showing the said genoa–jib furled to a point forward of the mast. Genoa batten 41B has been rolled around the roller-furling forestay mechanism 40. The clew of the said genoa-jib is now connected to a single self-tacking jib sheet 37, which leads to deck pulleys, thence to the cockpit of the said sailboat.

FIGURE 6A. SELF-TACKING ROLLER-FURLING CONVERTIBLE INNER HEADSAIL. SIDE VIEW

Figure 6A is a side view of a cutter-rigged sailboat carrying a semi-elliptical roller-furling convertible genoa-jib 22 furled completely around roller-furling forestay mechanism 40. A fully unfurled semi-elliptical convertible roller-furling convertible inner headsail 23A is shown attached to inner roller-furling forestay mechanism 40A. The foot length of this

version of the said headsail approximates that of a 125% overlapping genoa. The clew of the said headsail is attached to genoa sheets 47 leading to port and starboard genoa cars.(not shown).

FIGURE 6B.SELF-TACKING ROLLER-FURLING CONVERTIBLE INNER HEADSAIL. SIDE VIEW

Figure 6B is a side view of the said cutter-rigged sailboat showing the said semi-elliptical roller-furling convertible genoa-jib 22 furled completely around roller-furling forestay means 40. The said semi-elliptical convertible self-tacking roller-furling convertible inner headsail 23A is shown furled to a point aft of the mast. Batten 41A of the said sail has been furled around the inner roller-furling forestay mechanism 40A. The clew of the said sail is attached to genoa sheets 47, each of which lead to the said port and starboard genoa cars (not shown).

FIGURE 6C. SELF-TACKING ROLLER-FURLING CONVERTIBLE INNER HEADSAIL. SIDE VIEW

Figure 6C is a side view of the said cutter-rigged sailboat showing the said semi-elliptical roller-furling genoa-jib 22 furled completely around roller-furling forestay mechanism 40.

The said semi-elliptical convertible self-tacking roller-furling convertible inner headsail 23A is shown furled to a point forward of the mast, or to a self-tacking configuration. The said batten 41B of the said sail has been furled around inner roller-furling forestay mechanism 40A. The clew of the said sail is now attached to a single self-tacking jib sheet 37 leading to deck pulleys, thence to the cockpit.

FIGURES 7A to 7D. SEMI-ELLIPTICAL ROLLER-FURLING CONVERTIBLE GENOA-JIB SERIES.

Figures 7A through 7D each show an identical sailboat with different versions of a convertible semi-elliptical roller furling convertible genoa-jib attached to a conventional roller-furling mechanism.

The visible difference between the versions depicted in figures 7A to 7D concerns the unfurled foot length of each version. Each of the figures shows progressive furling of the sail version depicted

Figure 7A shows a version of the said genoa-jib, whose foot length is significantly longer than conventional genoas, in a fully unfurled and in a partially furled configuration. The version shown in figure 7A is usually constructed of lighter cloth than versions shown in figures 7B through 7D.

Figures 7B through 7D each show convertible genoa-jib versions, which correspond approximately to conventional genoa foot lengths of 150%, 135%, and 110%. Each such version is depicted furled to self-tacking configuration.

Versions having unfurled clew points aft of the said vessel's genoa track are shown with genoa sheets 47 leading to corresponding spinnaker blocks, port and starboard (not shown), thence to the cockpit of the said sailboat..

Clew points falling between the aft end of the genoa track of the said sailboat and a point aft of the mast of the said sailboat are attached to port and starboard genoa sheets 47 leading to port and starboard genoa cars (not shown), thence to the cockpit of the said sailboat.

Clew points forward of the mast of the said sailboat are shown with the clew of each such version attached to a single jib sheet 37 leading to deck pulleys (not shown), thence to the cockpit of the said sailboat.

FIGURES 8A AND 8B, VERTICALLY AND HORIZONTALLY DEPLOYED SEMI-ELLIPTICAL SAILS. ALTERNATIVE EMBODIMENTS

Figures 8A and 8B each depict alternative embodiments of sail system elements described above. Such alternative embodiments may take the form of either headsails or mainsails. Each is shown on a large, three-masted vessel. The construction of the said sails conforms to the respective descriptions found in preceding figures.

Elements of conventional sails including without limitation, leech and foot lines; as well as parts of the present invention, including without limitation, the said **batten-substitute means 41, leech taping 41D and leech stiffening junction 41E**,**and batten end-plate means** may be applied to the alternative embodiments depicted in figures 8A and 8B, even if not shown. The particularities of each such embodiment and its operation, as applied to such a vessel is discussed below under "Operation of the Preferred Embodiment."

It should be **specifically noted** that **substitute batten means 41, leech taping means 41D, and roach stiffening junction 41E** can comprise not only material attached to a sail by conventional means, but also material applied directly into or onto a sail matrix by a variety of methods or processes, as noted above.

Such methods may be employed for fabrication of particular and unique aspects of the present invention, including, without limitation, **substitute batten means 41, leech taping means 41D, and roach stiffening junction 41E.**

OPERATION
MAIN EMBODIMENT

The main embodiment of the present invention comprises a sail system having three basic components:

1. **a semi-elliptical roller-furling convertible genoa-jib 22**
2. **a semi elliptical self-tacking jib 23**; and
3. **an automatic jib stowage bag 44**

The said sail system reconciles several potentially conflicting design objectives, namely:

1. **performance**
2. **crew safety**
3. **ease of use**
4. **durability**
5. **cost effectiveness**
6. **broad market appeal**

Each component of the present invention represents a solution to a problem that has heretofore been considered insurmountable. Each such problem and its solution are discussed below.

HEADSAIL PERFORMANCE - BACKGROUND

From the earliest times it was believed that more headsail area necessarily yielded higher sailing speed and better windward performance. Later it was argued that while more sail area improves performance when sailing with the wind aft of the beam, windward performance would not improve significantly by increasing headsail foot length beyond approximately 1.4 times “j”, for genoas fixed to a stay, herein referred to as “in-place overlapping headsails.”

From that point in time, designers concentrated on developing free-standing sails for offwind performance and accepted as dictum that a genoa fixed to a stay was best suited to windward sailing and close reaching. For broad reaching and running, free-standing sails were considered the only real performance choice.

These prejudices ignored the needs of cruising sailors as opposed to racing sailors and the nature of their boats and crews along with the true potential of modern headsail furling gear.

As noted above, by 1925 Manfred Curry had argued that optimum sailing performance depends as much on control of heeling forces as on a sail's surface area. The elliptical distribution of force over a sail has long been accepted as ideal for minimizing heeling forces while obtaining maximum forward drive, or optimum performance. Fully battened semi-elliptical mainsails for racing monohulls and for virtually all multihulls appeared, but semi-elliptical in-place headsails did not.

In-place headsails are the predominant headsails on modern sailing craft. Thus, the vast majority of sails used on modern sailboats remain triangular in shape, with the inevitable sacrifices in surface area, efficiency, and ease-of-use.
Research has yielded more efficient three-dimensional headsail plans, lighter and stronger materials, and more resistant assembly methods such as radial and step-up construction. Such improvements would enjoy extreme synergy if they were employed in sails having an efficient semi-elliptical form.

Until now lengthening the foot of triangular in-place headsails has been the only manner of increasing their surface area. The present invention takes an entirely different approach to optimizing in-place headsails.

The present invention simultaneously augments in-place headsail surface area and optimizes in-place headsail efficiency by systematically

integrating a large, semi-elliptical positive leech curve and positive foot curve into the design of such sails.

Thus, such headsails simultaneously gain surface area and optimum efficiency by way of vertical expansion within the spatial limits of existing standing rigging, but without compromising windward performance. Stated otherwise, the present invention puts more sail area of a more efficient form into the same space available to a less powerful and efficient triangular sail, but with no modification to existing standing rigging.

CREW SAFETY – BACKGROUND

Simplifying sail maneuvers enhances crew safety, thus reducing the number of crew required to perform such maneuvers and by reducing the risk and effort required to perform them. The cumulative effect of such improvement results in a significant reduction of crew fatigue, which is the cause of an important portion of sailing accidents.

A major objective of the present invention is to reduce to a minimum the need to leave the safety of the cockpit while a sailboat is under way.

A further objective is to eliminate sail changes entirely along with eliminating the use of spinnaker poles or whisker poles, each of which presents important risks to crewmembers. Thus, a modern sailboat can be navigated at high performance levels without large crews and high levels of fatigue.

Inevitably, crew fatigue and sailboat performance are incompatible. If a boat can be driven with an important reduction in crew effort, mean boat speed will be improved.

Perfect sail handling in difficult conditions may be achievable by professional sailors. It is an entirely unrealistic and unsafe objective for the vast majority of sailors. The present invention addresses not only the

realistic needs and objectives of this vast majority, but offers real advances and advantages for the racing sailor, as well.

CONVENTIONAL MATERIALS AND METHODS – BACKGROUND

Throughout the present application reference to conventional materials and methods comprises all known and readily available materials and methods for building sails including, without limitation, patented means for building molded and glued sails.

MODERN ROLLER-FURLING MECHANISMS. BACKGROUND

Prior to the appearance of modern roller-furling mechanisms, sails were folded or rolled for stowage. The use of battens to support a positive roach on a headsail was inconceivable since it is neither safe nor practical to remove and replace battens each time a headsail is hoisted or lowered and stowed, not to mention the problem of stowing the battens when not in use.

The development of modern roller-furling mechanisms opened the possibility of creating a headsail with a positive roach supported by battens. However, none appeared prior to the present invention.

Efforts were made to commercialize roller-furling mainsails with a minimal roach supported by short battens fitted at the leech. These battens were intended to allow at least a straight leech that would not vibrate. Such sails provided no significant performance benefit. Efforts to develop battens capable of being furled horizontally around a roller furling extrusion mounted in or behind a mast likewise proved less than functional.

As for headsails, prior to the present invention, furling headsails

incorporating significant positive roach simply did not exist. A battened semi-elliptical roller-furling headsail attached to a stay, and capable of assuming a self-tacking configuration, was not only unknown, but was considered an outright impossibility.

UNIQUE SAIL GEOMETRY - BACKGROUND

American naval architect and boat builder Walt Schulz stated in 1999 that "...it is still impossible to roller furl a large overlapping genoa into a useable and safe working jib." (Ocean Navigator no.100, October 1999). One component of the present invention accomplishes exactly what Walt Schulz deemed impossible.

A positive roach can add 25% or more to the surface area of a conventional triangular sail. The advantage is not only increased area, but also increased efficiency.

A positive foot area or skirt complements the positive roach of the roller furling convertible genoa-jib seen in figure 1A. The combination of the positive roach and skirt result in a sail that retains its ample and efficient semi-elliptical shape from fully unfurled to self-tacking configuration while providing correct sheeting angles throughout its design furling range. This result has heretofore been considered unachievable.

Various configuration of the said genoa-jib are shown in the drawings attached hereto. In each of them, the clew of the said genoa retains an efficient sheet lead angle as each such version is furled. This is not the case when furling a conventional triangular furling headsail, which quickly becomes too small for practical use in prevailing conditions, and, which quickly loses its shape and proper sheet lead angle as it is furled.

A. SEMI-ELLIPTICAL CONVERTIBLE ROLLER-FURLING GENOA-JIB: INSTALLATION

As seen in Figure 1A, as the said semi-elliptical genoa-jib is hoisted initially, a plurality of battens 41A, 41B, and 41C, have been inserted at the foot of the said sail into batten pockets 49A, 49B, and 49C, which are parallel to roller-furling mechanism 40. The said batten pockets are then closed by conventional closure means 59A, 59B, and 59C at the foot end of the said batten pockets. The reverse process takes place when the said sail is removed for storage. Once removed, the said battens can be rolled individually and stored in the same bag as the folded or rolled sail.

The said battens and pockets must be at least long enough and sufficient in number to support the positive roach of the said genoa in its design wind range. Batten placement corresponds to reef points in each version of the said genoa-jib.

Such placement might correspond to conventional genoa foot lengths of 135%, 110% and 95% of "j", for example. A self-adhesive colored band (not shown) is just aft of each batten pocket at the foot of the said sail provides a visual reference for each reef point.

A SEMI-ELLIPTICAL ROLLER- FURLING CONVERTIBLE GENOA - JIB : PERFORMANCE

Creation of a semi-elliptical roller-furling convertible genoa-jib required that the positive roach of the said sail be supported while the sail was exposed to the design wind, and that the leech of the said sail be sufficiently light to be both controllable and dynamic, or responsive to changes in wind force and sea conditions. Solution of this problem lay

partially in the use of battens or batten substitute means fixed parallel to the said furling mechanism.

THE BATTENS

The preferred embodiment of the said genoa-jib 22 employs semi-rigid battens fixed parallel to the luff of the said headsail, as shown in figure 1A, which placement permits the said battens to be furled easily. The said battens can be full length from leech to foot, or they can be shorter, but they must be sufficient in number and rigidity to support the positive roach of the genoa-jib, yet allow the leech to respond to changes in wind and wave conditions.

It is believed that such battens must have a length equal to least twice the distance from the triangular demarcation of the sail to the leech at the point the batten in question is fixed to the leech.

The **preferred embodiment** of the subject sail employs full-length battens for optimized furling, as opposed to foam inserts or other methods currently used to improve furled headsail shape. Use of full-length battens eliminates the risk of mildew inherent in the use of such foam inserts as well as the risk of the said foam compressing, thus losing its effect.

Alternatively, a **batten-substitute means 41** comprising attached material; or specific fibers laid directly into a molded or laminated sail, can be placed as shown, as a support for such full or partial-length battens **(or as a substitute for such battens).** It is believed that as sail making technology evolves, batten-substitute means will eventually provide adequate roach support and will optimize furled sail shape, thus replacing battens entirely.

Battens parallel to the luff of the said sail not only support its positive roach and improve its furled shape, but they reduce destructive sail vibration in difficult conditions and stabilize the leech of the said genoa-

jib. Conventional roller-furling sail designs do not address this problem.

ROACH STIFFENING MEANS: SEMI-RIGID LEECH TAPING 41D & ROACH STIFFENING JUNCTIONS 41E.

Also seen in figure 1A, is a plurality of battens, and semi-rigid leech taping 41D to contain the leech line of the said headsail and to unify its leech area. The said taping comprises mylar ™ or other material whose physical properties unify the leech curve while accepting repeated furling without deterioration. The said material is folded over the leech and attached using conventional means.

To further enhance sail shape and stability, a plurality of roach stiffening junctions 41E are attached to the sail by conventional means as seen in figure1A. The said roach stiffening batten junctions are constructed of bands of semi-rigid material having characteristics similar to the said leech taping and attached to the sail by conventional means.

The objective of the said roach stiffening means is to transfer loading between the said semi-rigid battens and thus augment the integrity of the positive roach area. These stiffening means can be used to optimize response characteristics of the leech of the said genoa-jib, according to the material employed and the design and frequency of such stiffening means.

Alternatively, these stiffening mean and, indeed, the substitute batten means, themselves, may comprise fibers laid onto sail matrix by various existing methods such as the patented North 3-D and patented Sobstad Genesis methods, thus becoming an integral part of the sail, itself.

2. SEMI-ELLIPTICAL ROLLER-FURLING CONVERTIBLE GENOA–JIB: CREW SAFETY

The subject component of the present invention allows deployment, recovery, and reduction of a roller-furling, semi-elliptical convertible genoa-jib 22 from the safety of the cockpit. Thus, a sail fixed to a stay can now offer performance approaching or exceeding a spinnaker, while eliminating the inevitable deck maneuvers a spinnaker demands.

When furled to self-tacking configuration, the said convertible genoa-jib 22 eliminates the changing of port and starboard sheets and winching, which involves significant crew effort and risk in the event of repetitive tacks. Since it is envisioned that the subject headsail will eliminate sail changing, the accompanying effort and risk are also eliminated. The reduction of crew fatigue by the present invention contributes to crew safety in an important manner.

A semi-elliptical sail induces less heel than a conventional triangular sail of equivalent area. A more level working platform likewise contributes to crew equilibrium and safety. Finally, the ability to achieve higher average boat speed over a given distance reduces the time during which crew is exposed to changes in weather or other hazards.

3. SEMI-ELLIPTICAL ROLLER-FURLING CONVERTIBLE GENOA- JIB: EASE OF USE

The leech of the subject genoa-jib will be more responsive to changes in wind strength, making the sail more dynamic in its response, and a boat will advance more uniformly than with a triangular sail. The subject genoa-jib will simply be more stable than a triangular sail. Furling the said genoa-jib to self-tacking configuration reduces tacking to a simple task, compared to the winching and sheet changing required by a non self-tacking sail. Either the genoa sheets are left attached, but in equal tension, or preferably, a single self-tacking sheet replaces the genoa sheets when the said headsail is rolled to self-tacking size.

The said self-tacking sheet may be left in place permanently and attached to the clew of the said headsail as desired.

Downwind, the semi-elliptical shape supported by battens or batten substitute means provide the stability that can eliminate the need for a whisker pole or spinnaker pole, each of which must be set and taken down. The said headsail likewise requires far less adjustment than a conventional non-battened triangular sail when sailing downwind. When furled to self-tacking size, the subject sail is ideal for use as a downwind sail in combination with mainsail or a second headsail, with virtually no effort required to set up the sail combination. Typically, the forward headsail is furled to the desired size. Then, if two headstays are present, the inner foresail is deployed and regulated.

4. SEMI-ELLIPTICAL ROLLER-FURLING GENOA-JIB: DURABILITY.

The stability provided by the said head sail's battens or batten substitute means reduces destructive leech vibration in difficult wind and sea conditions, thus improving markedly the life of the said semi-elliptical genoa-jib. In contrast to conventional, unbattened roller-furling sails, the reinforced reef points and companion battens combat deterioration of the shape of the said sail. Moreover, risk of sail damage is significantly less than in the case of a free- standing sail which can go into the water or be otherwise damaged while being raised or lowered.

5. SEMI-ELLIPTICAL ROLLER-FURLING GENOA-JIB: COST EFFECTIVENESS.

The said semi-elliptical genoa-jib 22 replaces the several conventional triangular sails required to cover a given wind range. A triangular roller-furling genoa cannot cover a wind range comparable to that covered by the said semi-elliptical convertible genoa jib 22.

The greater surface area of the said semi-elliptical sail for a given foot length, and the reduced heeling moment offered by the said semi-elliptical sail extends its design wind range well beyond that of a triangular genoa of comparable surface area.

Coupled with the improved sail life of the semi-elliptical roller-furling convertible genoa-jib 22, the incremental cost of battens and batten pockets is more than justifiable. In addition, the necessity to motor in light wind conditions will be significantly reduced, resulting in savings in fuel costs and reducing motor hours.

The present invention likewise delivers major cost savings for new boat construction, where the use of easily managed semi-elliptical sails allows for the use of shorter masts, shorter rigging elements, and less ballast, or alternatively, increased performance using existing rig specifications. The cost and marketing benefits to boat builders from specifying such semi-elliptical sails can be remarkable.

6. SEMI-ELLIPTICAL ROLLER-FURLING GENOA-JIB: BROAD MARKET APPEAL

As the sole headsail on a single headstay sailboat, a semi-elliptical genoa-jib is an innovation which offers maximum benefits to this predominant market segment. The foot length and positive foot curve and roach as well as the sail construction and materials of the said genoa-jib combine to accommodate a far broader design wind range. Such a headsail has broad appeal for new boats as well as for the replacement sail market.

While boats with multiple headsails are fewer in number, the application of the said genoa-jib 22 to one or all of such multiple headstays is equally convincing. This holds true whether horizontal or vertical deployment is chosen.

Alternative embodiments are discussed below as concerns cargo and passenger vessels as well as rig configurations other than the Marconi rig found on most modern sailing vessels.

SUMMARY
SEMI-ELLIPTICAL ROLLER-FURLING GENOA JIB 22

Regardless of the design wind range, the present invention results in a sail having more efficiency and more surface area than a triangular sail of comparable foot length. The said semi-elliptical genoa is quicker to deploy, to recover, and to reef because its area has been increased vertically, not along the foot.

These benefits are available to virtually every modern sailboat at a small cost increment over a triangular sail of equivalent area. Indeed, a semi-elliptical genoa-jib can expose to the wind as much as 25% or more surface area than a triangular headsail of like foot length. In a maxi-

surface version, the subject headsail's area approaches that of an asymmetrical spinnaker without the complication and effort of the latter. No triangular sail comes close.

B. SEMI-ELLIPTICAL SELF-TACKING JIB

1. SEMI -ELLIPTICAL SELF-TACKING JIB: INSTALLATION

Readying the said semi-elliptical self-tacking jib for navigation begins by inserting upper jib battens 25A, 25B, and 25C into their respective batten pockets, which are then closed using conventional closure means (not shown). The topping lift 106 is attached to the clew ring 104 by a knot or other conventional means, and the patented Dutchman system is attached to the said topping lift and to Dutchman tabs 108 and 108A as detailed in the said Dutchman patent and shown in **figure 4A.**

Next, with the sail on the deck, insert lower round diagonal jib batten 38A and intermediate round diagonal jib batten 38B through their respective leech batten boxes, 65B and 66B, thence passing through their corresponding batten pockets, 24A and 24B, thence into the their corresponding luff batten boxes 65A and 66A. Typically, threaded plugs are then inserted into the said leech batten boxes to secure the said battens and adjust their tension.

The sail may now be attached to its stay, beginning with lower jib luff batten boxes, 65A and 66A, each of which terminate at its luff end in threaded, forked terminals(not shown). The said forked terminals are placed over the inner forestay 19 and secured by means such as a pin and cotter pin, or a·pin with integral toggle (not shown).

The remaining sail to stay attachments comprising conventional headsail hanks (not shown) are then attached to the stay.

With the sail lowered, a conventional jib downhaul 30 is attached to an eyelet just below the head of the sail, thence led to a deck block (not shown), at the foot of the inner forestay and thence to the cockpit.

Next, jib reef line 30 is attached by a knot or other conventional means to the clew ring of the said jib. The said reef line leads through a turning means such as a pulley or eyelet (not shown) at reef point 27B, thence through a similar turning means (not shown) at reef point 25A, thence through a deck block (not shown) at the foot of the inner forestay 19 and aft to the cockpit.

The sail is then hoisted, and the patented Dutchman control lines installed and adjusted to proper length as detailed in the said Dutchman patent and Dutchman owner's manual. At this point the said semi-elliptical self-tacking jib 23 is ready for use.

VERTICALLY DEPLOYED SEMI-ELLIPTICAL SELF-TACKING JIB PERFORMANCE ADVANTAGES

The said vertically deployed semi-elliptical self-tacking jib 23 has a narrower design objective than a multi-purpose roller furling sail, and it is raised and lowered as opposed to being furled and unfurled. The said sail has no need for foam inserts or other furling attachments which compromise performance.

As such, this vertically deployed sail can provide a more constant sail shape than a comparable furling sail and approximately 15% more surface area than a triangular sail with like foot length. The ideal application for the said jib is on boats having a large mainsail and/or multiple headstays, as in **figure 1**,

As the subject sail is hoisted, the forked, threaded jaw terminal of lower luff jib batten box 65A containing lower round diagonal jib batten 38A is forced against the inner forestay by halyard tension and renders the said jib self-boomed and self-vanged. These are major advantages over a conventional headsail, regardless of whether it is boomed or non-boomed.

While wishbones and club jib booms are costly, heavy, and cumbersome, the simple round diagonal battens used in the subject jib are inexpensive, durable, and lightweight, while accomplishing the same tasks as the former devices. This important and comprehensive economy, when combined with the semi-elliptical shape and other properties of the subject sail comprise its uniqueness and its surprising performance and convenience advantages.

Thus, where the conventional sail collapses with wind changes, or as a boat enters the trough of waves, the subject working jib 23 retains its shape and continues to drive the boat. The stability of the said jib 23 is far greater than that of a conventional sail, and changes in wind and sea conditions are absorbed without the violent shocks introduced by the filling and emptying of a conventional sail.

Having covered the advantages of both the horizontally deployed semi-elliptical genoa-jib 22 and the vertically deployed semi-elliptical self-tacking jib 23, it is appropriate to compare the unique merits of each

THE SEMI-ELLIPTICAL FURLING CONVERTIBLE GENOA-JIB 22

v.

THE VERTICALLY DEPLOYED SEMI-ELLIPTICAL SELF-TACKING JIB 23

A semi-elliptical roller-furling convertible genoa-jib 22 can be more versatile than a semi-elliptical self-tacking jib 23, but the absence of self-booming and vanging render the furling sail 23 less stable than the vertically deployed sail 23, which will also have better upwind performance.

Downwind and in erratic wind and wave situations, the self-booming and self-vanging of the latter sail more than compensates for the slight additional effort needed to open and close an automatic stowage bag 44

(discussed below) and to raise and lower the said sail, given its Dutchman and downhaul control means.

The ease of reefing the two types of sails is roughly equivalent. Furling a sail against the force of the wind can require considerable effort, whereas gravity assists in lowering the vertically deployed working jib 23. In addition, a furling sail can flap considerably when being furled in all but light wind, although the vertical battens of the said genoa-jib 22 minimize this problem,

Whichever version of the present invention is chosen, it will provide a unique synergy resulting in maximum accommodation of performance and ease of use, a result not even suggested by earlier systems.

ALTERNATIVE EMBODIMENTS

SEMI-ELLIPTICAL ROLLER FURLING CONVERTIBLE GENOA-JIB 22& SEMI-ELLIPTICAL SELF-TACKING JIB 23

GENERAL COMMENTS

Various alternative embodiments of the three components of the present invention are illustrated comparatively in figure 8A. and 8B, as the might be employed on large multi-masted vessels. The said alternative embodiments can apply equally to smaller vessels.

Anywhere there is a stay or a mast carrying a sail, a choice can be made between a horizontally deployed, semi-elliptical furling sail and a vertically deployed, semi-elliptical sail.

The choice between horizontally or vertically deployed sails extends to mainsails as well as headsails. Thus, either roller furling semi-elliptical convertible genoa-jibs or semi-elliptical self tacking jibs can comprise the following additional embodiments, which are, discussed below::

a. a horizontally deployed semi-elliptical mainsail 125, or
b. a vertically deployed semi-elliptical mainsail 126.

ALTERNATIVE EMBODIMENTS

SEMI-ELLIPTICAL ROLLER FURLING CONVERTIBLE GENOA–JIB 22 & SEMI-ELLIPTICAL SELF-TACKING JIB 23

APPLICATION TO A HORIZONTALLY DEPLOYED NON-BATTENED HEADSAIL 22B TO A PLEASURE CRAFT FIGURE 1D.

Figure 1D shows a sloop-rigged sailboat that carries a horizontally deployed, non-battened, vertically deployed semi-elliptical headsail. It is believed that roach stiffening means 41D and 41E will support the positive roach of the said sail and allow it to be lowered and otherwise maneuvered with ease. The construction of the said roach stiffening means was discussed above and will not be reiterated here.

ALTERNATIVE EMBODIMENTS
SEMI-ELLIPTICAL ROLLER-FURLING CONVERTIBLE GENOA-JIB SEMI-ELLIPTICAL SELF-TACKING JIB COMMERCIAL VESSELS AND ALTERNATELY RIGGED VESSELS.

1. The semi-elliptical roller-furling convertible genoa-jib 22, as well as the semi-elliptical self-tacking jib 23 offer major advantages to vessels currently using a plurality of triangular sails as primary or supplementary propulsive means, either as headsails or mainsails. Examples of such additional embodiments appear in **figures 8A and 8B ,** discussed below:

HORIZONTALLY DEPLOYED SEMI-ELLIIPTICAL ROLLER FURLING MAINSAIL 125

To date, furling mainsails have remained without roach or battens except for the minimal battens mentioned above, which offer little in terms of sail

efficiency or increased surface area. The subject sail presents the possibility of using low-volume battens or batten substitute means in conjunction with the said roach stiffening means to support the positive roach of the said sail, thus minimizing problems with such a mainsail entering into a conventional furling mast aperture on smaller vessels, and reducing weight aloft for all vessels using such sails.

Configured as a mainsail, a horizontally deployed semi-elliptical sail 125 offers major performance advantages over its conventional triangular counterpart for reasons set forth above.

A semi-elliptical furling sail is shown as a non-boomed mainsail 125 attached to the forward mast of the vessel depicted in **figure 8B**. The said sail is controlled by a conventional sheet at its clew and an upper sheet 128 at the tip of a full length batten running from the clew of the said sail upward along its vertical leech, as shown. This dual sheeting provides additional control over the leech of the said sail.

Two embodiments of the said sail appear as non-boomed mainsails on the after most masts of the vessels in **figures 8A and 8B.** The former is a battened sail, the latter employs full-length **batten-substitute means 41** in lieu of battens. In the case of a molded or laminated sail, such substitute means could be fibers laid directly into the sail matrix. The said sails furl around furling extrusions fitted either within the said masts or aft of the said masts. Such applications of a horizontally deployed semi-elliptical furling mainsail may be boomed or non-boomed. Such sails could also be fitted to cat ketch rigs with free-standing masts.

. ROLLER-FURLING CARGO BOOM 124 AND VERTICALLY DEPLOYED ROLLER-FURLING MAINSAIL 126.

Figure 8B. depicts a different type of semi-elliptical furling mainsail aft of its middle mast. The said sail is a vertically deployed, semi-elliptical battened mainsail 126, which furls into a roller-furling cargo boom 124.

The said boom comprises a boom housing which encloses an appropriately sized mainsail roller-furling mechanism. Such a sail enters an appropriately sized roller-furling boom without difficulty.

The said boom may also serve as a cargo boom once its sail is furled into it, thus providing a multipurpose boom in circumstances where one is particularly appropriate. Such a boom provides a large surface, to which solar panels (not shown) can be applied, as well.

A semi-elliptical sail, as applied to large vessels, with the boom additionally serving as a cargo boom and solar cell platform, provides benefits in excess of any single element of this particular embodiment.

VERTICALLY DEPLOYED, NON-BATTENED SEMI-ELLIPTICAL HEADSAIL 22B.

It is envisioned that the evolution of a combination of leech taping 41D and roach stiffening junctions 4E will eventually provide adequate unity to the positive roach of a vertically deployed, semi-elliptical sail to allow the elimination of battens. Battens can improve the aerodynamic furling of a sail, but this is not a consideration where a vertically deployed or non-furling sail is concerned.

VERTICALLY AND HORIZONTALLY-DEPLOYED, SEMI-ELLIPTICAL, NON-BATTENED, NON FURLING HEADSAIL 22B ON A LARGER VESSSEL. FIGURE 8A,

Figure 8A depicts a large vessel that carries a vertically deployed, non-battened headsail on its forward most stay, and furling sails forward of its two masts and a furling mainsail on the aft mast.

As used on larger vessels, it is anticipated that such vertically deployed sails will generally be non-overlapping, and employ either lazy jacks, as

shown in figure 8A. or a Dutchman sail control system as seen in figure 8B.

Figure 8B shows a vertically deployed semi-elliptical self-tacking jib 23 in the foretriangle of a large, three-masted vessel. Such a sail could as well have been applied in figure 8A to all or any of the three available stays instead of the furling sails shown. An automatic jib stowage bag 44 (not shown) could be used in all cases where non-overlapping sails are vertically deployed. The merits of each alternative have been discussed above and will not be repeated here.

Whether vertically or horizontally deployed, the increased surface area and efficiency of a semi-elliptical sail will be appreciated particularly by operators of large vessels in terms of reduced heeling, reduced fuel costs, and reduced sail wear, as compared to the non-battened triangular sails currently used such vessels. It should be noted that the Luna Rig patented by Richard Carter would have been far more satisfactory had semi-elliptical furling headsails been available to this rig. Its lack of commercial success was due largely to its inadequate power for a wide range of wind conditions.

Figure 8B also illustrates the use of a **headboard-end-plate means 126A** used on the vertically deployed mainsail carried on the middle mast of the vessel shown in that figure. The said headboard-end-plate headboard means could be constructed of metal, composite material, or of a combination of known materials, allowing this component to serve at the same time as a headboard and extended end plate.

It is believed that such an end plate means will inhibit induced drag, as discussed above, Such a headboard end-plate means is applicable to any vertically deployed sail. Finally, the said headboard end-plate means can comprise radar-reflective properties, which allow it to serve not only performance, but safety needs as well.

The said headboard end-plate means can incorporate a flat or curved

horizontal end-plate element, as desired. The said end-plate element can be long enough to produce the optimum end-plate effect, yet impose no modification to the design of a new sail, or modification to an existing sail. Thus, the said headboard end-plate means can be retrofitted as well as applied in new sail construction. As an after market item, such headboard-end-plate means should have considerable market appeal.

A. AUTOMATIC JIB STOWAGE BAG

THE DESIGN OBJECTIVE

Create an automatic jib stowage bag possessing the following properties:

1. ease of use approaching that of a non-overlapping roller-furling sail;
2. Safety equal to or greater than a non overlapping roller-furling sail;
3. Compatibility with known sail control systems such as lazy jacks or the patented Dutchman system;
4. compatibility with all non overlapping vertically deployed jibs
5. simple installation requiring no additional on deck or below deck hardware or modifications:
6. Compatibility with remote jib reefing for any working jib.
7. Low incremental cost and on-board sizing
8. Supported independently of lazy jacks or the sail, itself.

AUTOMATIC JIB STOWAGE BAG

THE SOLUTION

A combination of an entirely new bag concept with known control means such as lazy jacks or the patented Dutchman system to bring to vertically deployed sails the convenience of furling sail systems without imposing the compromises and added expense inherent in such furling sail systems.

AUTOMATIC SAIL STOWAGE BAGS

BACKGROUND

CONVENTIONAL MAINSAIL STOWAGE BAGS

Conventional sail stowage bags have long been attached to mainsail booms to reduce the considerable effort required to install and remove a mainsail cover each time the sail is put into use or is to be stowed. . Such bags were an important advance in protecting mainsails, but no satisfactory equivalent appeared for the protection of headsails, where no boom or mast was available for attaching such a bag.

One example of known automatic mainsail stowage bags, also called "lazy bags", is found in U.S. patent no. 4,741,281, 1988, to Doyle. The said bag, like virtually all such bags, is open-ended and is suspended full height at all times. In most applications, the said Doyle bag is supported full height by gussets sewn to the sail, in contrast to other bags which, almost uniformly, are supported by lazy jacks. Without regard to the shortcomings of such bags, they have common characteristics particularly inappropriate to use for protecting headsails.

AUTOMATIC JIB STOWAGE BAG 44

Automatic jib stowage bag 44 proceeds on a path diametrically opposite to the said Doyle bag and other existing sail stowage bags. It also goes far beyond the abovementioned rudimentary jib bags which simply allowed fitting a jib into a bag while the jib remained attached to its stay, but did not provide automatic flaking. More importantly, such bags required on deck sail handling in dangerous conditions and did nothing whatever to control the sail during deployment and recovery

Rather than presenting a full height profile to the force of the wind, the subject bag 44 is lowered to the level of the foot of the companion sail for navigation, thus presenting a minimum profile to the wind. Furthermore, it is not attached to the sail and is easily removable.

Of equal importance, once the subject bag 44 is installed, each of its ends are closed around a corresponding end of the contained sail, thus presenting a smooth profile to the wind and preventing ballooning of the bag entirely. Finally, no additional cover is required for the head of the sail, as is often the case with known sail stowage bags.

As seen in **figures 3 and 3A** the subject bag is at full height when in a stowage mode. When lowered for navigation, it presents a low, closed-end, minimum profile to the wind, as seen in **figure 3C**. This minimum profile in navigation mode presents far less wind resistance and far less disturbance to wind flow than does a high profile, open-ended bag. The improvement in the stability of the bag is remarkable.

AUTOMATIC JIB STOWAGE BAG INSTALLATION

a, Installation begins with the bag laid flat as in **figure 2**. The five bag battens are inserted consistent with figure 2. The cordage comprising forward lateral support means (110, 110A), forward central support means (112) and aft lateral support means (114,114A) and aft central support means (116) are attached to corresponding attachments points 94using knots

b. Flexible tubes 88 and 90 are inserted through the forward ends of forward upper and lower bag extension batten pockets 79A and 79B, and slid over the respective forward ends of battens 84A and 86A such that the holes in the said battens and tubes align consistent with **figures 2, 2A, and 2B.** Fixing means 89 are inserted into each such batten to tube union and secured using integral toggles 89A;

c. Aft, flexible tubes 88A and 90A are inserted through aft upper and lower bag extension pockets 79C and 79D in a similar manner and fixed to the respective aft ends of the said battens using fixing means 89 and integral toggles 89A, consistent with figure 2 and figure

2B; The bag now mirrors **figure 2**, laying flat on the deck with its forward end against the base of the inner forestay 19;

d. Slide flexible tubes 88 and 90 over the forward ends of battens 84 and 86, respectively; align the holes as above, and fix the said unions with fixing means 89, then toggles 89A, consistent with **figure 2B.**

e. Fix closure extension 74 to the central section of the bag 72 consistent with **figure 2**;

f. Repeat the above procedure at the aft end of the bag, bringing closure extension 76 aft
of topping lift 106 and jib sheet 37 and insert and fix the aft flexible tubes over their corresponding ends;

g. Fix closure extension 76 to the central section of the bag consistent with figure 2B.

h. The bag 44 is now lying on the deck, and it is closed forward of the inner forestay, strop and jib downhaul forward. Aft, it is closed aft of the topping lift and jib sheet.

i. by attaching the said fore and aft central and lateral support means to the forestay forward and to the topping lift aft as detailed in **figure 3C.**

AUTOMATIC JIB STOWAGE BAG: SPECIFIC DESIGN CONSIDERATIONS

1. PERFORMANCE

a. Known sail stowage bags can fill with wind, or balloon. The subject bag does not suffer from this problem since it is closed at both ends. In addition, the subject bag presents a minimum profile to the wind and is secured both forward and aft as a unit, as opposed to two independent, open-ended flaps, as in the case of conventional lazy bags, including the Doyle bag. As such, the subject bag presents an entirely new approach to in-place sail stowage, as seen in **figure 3C.**

The low profile, closed and unified assembly of the subject bag 44 is stable where known high profile bags balloon. As such, known stowage bags, whose use is limited to mainsail stowage, and whose open forward end is in the wind shadow of the mast, are unsuitable for headsail stowage.

b. Airflow leaking above and below the extremities of a sail diminishes performance. End plates have been applied to wing forms for this reason, and the present writer believes that the said stowage bag could act as a jib end plate, thus yielding an additional unexpected and unique benefit.

<u>2. AUTOMATIC JIB STOWAGE BAG</u>
<u>CREW SAFETY</u>

a. Insofar as the subject bag contemplates that lazy jacks or a Dutchman control system be used, and that the jib remain attached to its stay, the risk inherent in attaching, removing, stowing, hoisting or lowering a conventional working jib while under way is eliminated entirely since all sail handling is performed from the safety of the cockpit in total contrast to existing methods of handling vertically deployed jibs ;

b. Reduction of fatigue is significant when compared to conventional stowage bags that must be removed, replaced and stowed, in addition to flaking the sail they contain before and after each use of such sail. Since the automatic stowage bag and the jib it contains remain in place, considerable effort is saved with each maneuver, resulting in a more alert crew.

3. AUTOMATIC JIB STOWAGE BAG EASE OF USE

The said bag 44 provides convenience comparable to roller-furling mechanisms. It could take slightly more time to hoist, lower and cover a vertically deployed sail using the said bag than that required to unfurl, furl and secure a roller-furling sail.

However, in high winds, furling becomes difficult, and furling sails are not controlled during recovery. In contrast, the vertically deployed jib of the present invention descends aided by gravity and its downhaul, and is controlled during deployment and recovery, then secured automatically in the said automatic jib stowage bag 44 by the said downhaul and lazy jacks or patented Dutchman sail control system . There is no mechanism to jam or furled sail to flog during recovery or accidentally unfurl thereafter.

4. AUTOMATIC JIB STOWAGE BAG DURABILITY

To the extent that the subject bag is more stable than a given open ended, high profile sail stowage bag, the subject bag will suffer less abrasion and vibration damage than conventional bags, even if such were appropriate for jib stowage, which is not the case.

5. AUTOMATIC JIB STOWAGE BAG COST EFFECTIVENESS

The subject bag 44 does not require a supplementary cover for the head of the sail as many known lazy bags do. The user is motivated to use the subject bag regularly, as opposed to a bag that must be removed, stowed and replaced each time it is used. Experience indicates at least a 40% increase in sail life results from regular use of protective stowage.

Cost of the subject bag is equivalent to or lower than the cost of known mainsail lazy bags.

The unique on-board sizing capability of the subject bag will further reduce final bag pricing as opposed to conventional bags which do not have this capability.

6. AUTOMATIC JIB STOWAGE BAG BROAD MARKET APPEAL

Sailors who consider a vertically deployed sail more efficient and safer than a furling sail. have no choice but to continue using conventional sail bags, which must be removed, stowed, and replaced, before and after use, involving considerable time and effort. They likewise continue to struggle with lowering an uncontrolled working jib and to secure it once they get it on the deck.

The subject bag is the first sail stowage means which offers to this important market segment safety and convenience equivalent to furling systems for vertically deployed working jibs. The compromises imposed by furling sails are left behind.

Accordingly, it is anticipated that this market segment will be drawn naturally to purchase the said bag.

7. AUTOMATIC JIB STOWAGE BAG MODULARITY

The subject bag 44 provides its benefits independent of any other system component and requires no significant additional hardware and no above deck or below deck modifications. It is compatible with any vertically deployed, non-overlapping headsail, battened or non-battened; boomed or non-boomed.

8. AUTOMATIC JIB STOWAGE BAG: SYNERGY

a. The subject bag 44 delivers benefits in excess of its independent benefits when combined with a semi-elliptical jib 23 to the extent that ease of use and crew safety are combined with markedly improved performance. Further benefits are achieved when the said bag is used to support solar panels, or to carry the name of the vessel or to carry public relations logos, and when the bag is used for water catchment.

9. AUTOMATIC JIB STOWAGE BAG RETROFITABILITY AND VERSATILITY

The preferred embodiment of automatic jib stowage bag 44 is its use with a semi-elliptical self-tacking jib 23. As seen below under "additional embodiments" the said bag is equally advantageous for use with all other vertically deployed non-overlapping headsails, as well as vertically deployed mainsails.

ALTERNATIVE EMBODIMENTS.

AUTOMATIC JIB STOWAGE BAG.

STOWAGE OF NON-BOOMED HEADSAILS:

a. For stowage of non-boomed headsails other than the self-boomed jib 23 of the present invention, the central batten 83 of the subject bag can be constructed with integrity appropriate to merely stabilize the said bag, or alternatively, sized as a boom, thus offering self-booming benefits in advantage to other benefits of the said bag 44. In the latter case, the said central batten 83 would be attached to the forestay with a jib gooseneck fitting.

b. Automatic reefing of such a non-boomed jib other than jib 23 of the present invention is an option that would require a more substantial central batten and more substantial attachment points to the said jib and its stay. While automatic reefing of such a sail in connection with the

subject bag is easily realized, the said central batten, its attachment means, and its reefing means would mirror closely known club jib means and reefing means as well as those applicable to mainsails. These particulars need not be covered in detail for purposes of the present application, and clearly, jib 23 of the present invention is a superior choice from all respects.

c. Solar panels attached to the upper section of the bag may be oriented to the sun whether the said upper section is folded down for navigation or up and closed for stowage. Orienting means (not shown) angle the panels toward the sun when practical.

d. Water catchment means could be placed in the bottom of the bag using conventional material such as a through hull fitting to which a hose could be attached, thence led to a fixed or movable water storage means.

STOWAGE OF MAINSAILS

a. The abovementioned advantages of the subject bag 44 apply equally where the automatic jib stowage bag is configured as an automatic mainsail stowage bag 45.

In this embodiment, the said bag 45 is closed around the forward surface of the mast or attached to the sides of the mast, by means such as appropriately sized cordage or webbing attached to padeyes fixed to the said mast, or bolt ropes sliding into short lengths of companion extrusion riveted to the said mast.

b. Aft, the support means may be led to the clew ring; a topping lift, if present; or a purpose built boom attachment point (not shown), as convenient. Likewise, any needed cutouts in the said bag 25 can be made by any sailmaker, just as they would be made for a conventional cover. It is anticipated that the low navigation position of the said cover would eliminate the need for cutouts in most cases. This is a further

advantage with respect to conventional high-profile bags which require cutouts for reef lines, lazy jacks, etc.

AUTOMATIC SEMI-RIGID SAIL STOWAGE BAG

a. **Figures 3D and 3E** show an additional embodiment of automatic jib stowage bag 44, an **automatic semi-rigid sail stowage bag 45**, comprising two basic sections:

First, **a semi-rigid lower stowage means section 45A** constructed of a semi-rigid (or rigid) plastic material, either molded or laminated, having closed end sections, at least one of which can be opened for installation. The said lower section would be supported in the same manner as automatic jib stowage bag 44 or mainsail stowage bag 46, as detailed above. The said lower section could be manufactured in standard half-tube and end cap sizes for easy sizing.

Second, an **upper fabric stowage means section 45B**, which is_similar to the corresponding upper section of automatic jib stowage bag 44.

a. The said upper fabric section is attached to the said semi-rigid lower section by riveting, or the incorporation of a channel on the semi-rigid section to receive a bolt rope attached to the said fabric upper section. The said upper section would be closed in stowage mode and lowered in navigation mode in the same manner as the all-fabric embodiment, as shown in figures 3C and 3D, respectively.

a. The said semi-rigid lower section could more readily accommodate solar panels than a fabric lower section and would present a far smoother profile to the wind than a fabric lower section. In addition, it could be manufactured to incorporate a metal or composite boom tube at minimal incremental cost should the application of the said embodiment comprise a boomed headsail or mainsail.

b. The longitudinal section and end caps could be made in a minimum number of sizes, with the longitudinal section being cut to length. The fitting of the end caps would be a standard procedure. Thus, the construction of the said semi-rigid lower section would standardize construction of the stowage means to a large extent and reduce costs.

c. The said semi-rigid lower section would form an effective end plate to inhibit migration of air flow from the high pressure side of the sail to the low pressure side, thus increasing efficiency of the companion sail.

It is believed that such a semi-rigid section could also incorporate solar cells as an integral element of the construction material of the said semi-rigid section, or, alternatively, accommodate the chemical bonding of such cells to the said semi-rigid lower section.

d. Also shown is a stowage bag solar panel 44A attached to the fabric upper section of the said bag. Orientation means (not shown) may be provided to orient the said solar panels to the sun's angle when circumstances permit. The said solar panels may likewise be applied to an all-fabric automatic jib 44 or mainsail stowage bag 46, thus creating further synergy in the subject system

CONCLUSIONS, RAMIFICATIONS AND SCOPE

Accordingly, it can be seen that the present invention applies the most efficient aerodynamic form to in-place headsails, where such application has heretofore been considered impossible. The present invention makes possible the use of such unique in-place headsails on any wind-

powered vehicle by incorporating the said aerodynamic principles into versions of such headsails which are vertically deployed as well as to versions which are horizontally deployed. For the first time the present invention, by virtue of its automatic jib stowage bag, brings to the sailing market a true choice between vertically deployed and horizontally deployed headsails. Whichever choice is made, safety and ease of handling Invariably accompany optimum performance in the present invention. Compromises of the past are, indeed, a thing of the past.

A brief resume of only some of the advantages of the present invention points up its uniqueness, its unexpected advantages, and its synergy of result:

a. For the first time, uniquely versatile semi-elliptical sail performance for in-place headsails, resulting in minimum sail wardrobes
b. Optimum performance with reduced crew fatigue
c. Optimum crew safety
d. Elimination of on-deck sail handling
e. Minimum sail wardrobe at minimum cost to performance ratios
f. Elimination of below-deck and on-deck stowage of multiple headsails
g. Elimination of costly, dangerous jib booms and wishbones
h. Fully controlled jibs during deployment, navigation, and recovery maneuvers
i. Increased headsail life due to the reduced vibration of battened construction and maximum stability of the semi-elliptical form
j. Increased jib life due to the presence of in-place automatic jib stowage which may increase jib performance
k. Automatic jib stowage bags that offer on-board sizing, making possible important marketing and cost advantages
l. Major cost and marketing advantages to boat builders are inherent in a new choice between specifying lower rigs and less ballast, or to offer higher performance with heretofore standard rig dimensions.
m. A multitude of features that can attract new and broad markets ranging from unique automatic low-profile jib and mainsail stowage to radar-reflective headboard end-plates means to sail stowage incorporating solar energy means.

The present writer emphasizes that the foregoing is only illustrative of the unique aspects of the present invention. Not only are the individual components of the present invention unique in presenting heretofore impossible solutions to the sailing market, but when used in combination, such components deliver a heretofore unknown synergy of result. For the first time the sailor has access to uncompromised performance, safety and ease of use. The benefit of the present invention to sailors, to the sail industry, to the boat building industry and to the transportation industry are important and can be put in place immediately.

Although the description above contains many specificities, these should not be construed as limiting the scope of the invention, but as merely providing illustrations of some of the presently preferred embodiments of this invention. For example, the subject sails can be used on any wind-powered vehicle such as iceboats or other land vehicles. The end-plate effect of the headboard or the jib stowage bag may incorporate multiple features beyond those noted, for example, housing electrical connections for large solar arrays incorporated into fabric or plastic material, as made possible by developing technologies.

Thus, the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.